Comments on Vol 2 - California Water Plan Update 2013

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The East Bay Municipal Utility District (EBMUD) appreciates the opportunity to provide comments to Regional Reports in Volume 2 of the California Water Plan Update.

EBMUD service area is in the San Francisco Bay Hydrologic Region, but 90% of its water supply originates in the Mountain Hydrologic Region, and we have an interest in the Delta Region as well; therefore, we reviewed the Update 2013 with special interest on each of these Regions. As requested, our comments are contained in the attached pdf files. Thank you.

You may contact me at via email, *pjain@ebmud.com*, if you have any questions or need further information.

Sincerely,

Priyanka K. Jain

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Acronyms and Abbreviations Used in This Report

af	acre-feet
BCDC	San Francisco Bay Conservation and Development Commission
BDCP	Bay Delta Conservation Plan
Cal EMA	California Emergency Management Agency
CCC	Contra Costa Canal
CCF	Clifton Court Forebay
CVFFP	Central Valley Flood Protection Plan
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWC	California Water Code
DCC	Delta Cross Channel Canal
Delta Conservancy	Sacramento-San Joaquin Delta Conservancy
DFW	California Department of Fish and Wildlife
DMC	Delta Mendota Canal
DO	Dissolved Oxygen
DPC	Delta Protection Commission
DRMS	Delta Risk Management Strategy
DSC 2013	The Delta Plan
DWSC	Stockton Deep Water Ship Channel
EC	Electrical Conductivity
EPA	U.S. Environmental Protection Agency
ERP	Ecosystem Restoration Program
FEMA	Federal Emergency Management Agency
FRPA	Fish Restoration Program Agreement
GHG	Greenhouse Gas Emissions
HCP	Habitat Conservation Plans
HMP	State Hazard Mitigation Plan
IEP	Interagency Ecological Program
IRWM	Integrated Regional Water Management
ITP	DFW Longfin Smelt Incidental Take Permit
maf	million acre-feet
MOU	Memorandum of Understanding
NBA	North Bay Aqueduct
NCCP	Natural Community Conservation Plans
NDWA	North Delta Water Agency
NMFS	National Marine Fisheries Service
OMR	Old & Middle River
PCB	Polychlorinated Biphenyls
POD	Pelagic Organism Decline
ROD	CALFED Record of Decision
RWQCB	Regional Water Quality Control Boards

SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SFMP	State Flood Management Plan
SMPA	Suisun Marsh Preservation Act
SMPP	Suisun Marsh Protection Plan
SMSCG	Suisun Marsh Salinity Control Gates
SPFC	State Plan of Flood Control
SRCD	Suisun Resource Conservation District
SWP	State Water Project
SWRCB	State Water Resource Control Board
TMDL	Total Maximum Daily Load
UFMP	Urban Forest Management Plan
USACE	U.S. Army Corps of Engineers
VAMP	Vernalis Adaptive Management Program

Sacramento-San Joaquin Delta

Current State of the Region

Purpose of Overlay Area

Some areas of the state with common water issues or interests often cross the boundaries from one hydrologic region to another. California Water Plan (CWP) Update 2005 was the first water plan update in the Bulletin 160 series to describe overlay areas. DWR developed the concept of "overlay areas" to acknowledge that common water issues or interests often cross boundaries from one hydrologic region to another. The purpose of the overlay areas is to collect and provide information that will better enable planners and decision-makers to address issues in areas of special interest where both of the following criteria apply: (1) the area is of statewide significance — meaning that water management strategies and actions taken in one area affect much of the remainder of the state and (2) common water management conditions exist in the area — meaning that issues and integrated planning opportunities span more than one of the 10 hydrologic regions. The two overlay areas of special interest are the Sacramento-San Joaquin Delta (Delta) and Mountain Counties.

For Update 2005, the Delta and Suisun Marsh were included as an overlay area because of its common characteristics, environmental significance, and the important role it has in the State's water systems. The Delta and Suisun Marsh encompasses about 840,000 acres of tidal influenced land near the confluence of the Sacramento and San Joaquin rivers, and occupies portions of the Sacramento, San Joaquin, and San Francisco hydrologic regions. The geographic extent of the Delta overlay coincides with the statutory Delta boundary that defines the Legal Delta (California Water Code Section 12220) and the Suisun Marsh as defined in California Public Resources Code Section 29101.

Statewide Significance of the Delta

The Delta and Suisun Marsh are at the confluence of the Sacramento River and San Joaquin River basins, which drain about 40 percent of California. Collectively they cover about 1,315 square miles (Figure D-1) in portions of six California counties and are part of the largest estuary on the West Coast of the United States. Covering only about one percent of California's area, the Delta contributes much more to the state than one might expect from its size.

PLACEHOLDER Figure D-1 Sacramento-San Joaquin Delta and Suisun Marsh

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

The Delta serves as a hub for California's two largest water systems in the state, the federal Central Valley Project (CVP) and the State Water Project (SWP). A large part of the state is dependent upon water exported from the Delta to meet much of its agricultural and urban needs. Approximately two-thirds of the state's population live and work in urban areas that receive at least some of their water supply from the Delta. About 3 million acres of agricultural land are irrigated with exported water. In addition to providing water for farms, homes, and industry, water exported from the Delta provides significant water supplies to California's vital wetlands. Water from the Delta's watershed is also used within various areas upstream of the Delta and exported to areas around the state without going through the Delta.

The Delta watershed covers 40 percent of the state (Figure D-2). Many of California's major rivers converge on the Delta as tributaries of the Sacramento, the state's largest river, or the San Joaquin River. Entering the Delta separately are the Cosumnes, Mokelumne, and Calaveras rivers, the Yolo Bypass, and numerous smaller creeks and sloughs. The Sacramento River is the single outlet to Suisun Bay. For more on these rivers, see other Volume 2 reports for the Sacramento River and San Joaquin River hydrologic regions.

The Delta region is also important to the state because of its vital transportation and water conveyance facilities, ecosystem functions, and wide range of recreational opportunities. The Delta contains highways, railroads and shipping routes, natural gas storage and transmission facilities, electric transmission pathways, and gasoline product distribution pipelines. 80 percent of the state's commercial fishery species live in or migrate through the Delta. In addition, the Delta provides world-renowned boating, hunting, fishing, and nature viewing opportunities, with 12 million user-days annually (DPC 2012).

PLACEHOLDER Figure D-2 Sacramento-San Joaquin Delta Watershed

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Water Governance

More than 200 public agencies — federal, State, regional, and local — claim partial responsibility for governance, planning, facilities, or resource protections that utilize and safeguard the Delta and Suisun Marsh ecosystem. These diverse public agencies, and the legal requirements that guide them, form a complicated patchwork of governance with a complex history. Table D-1 is a partial listing of the more than 200 local, State, and federal agencies that have some jurisdiction and authority in governing water in and through the Delta.

PLACEHOLDER Table D-1 Agencies with Responsibilities in the Delta and Suisun Marsh

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In 2006, Governor Schwarzenegger's Executive Order S-17-06 created the Delta Vision Task Force to create a vision to repair the ecological damage to the Delta. The task force declared that the Delta problems could not be solved in isolation. The problems were inextricably linked to statewide water supply, habitat, and flood management programs, and that stronger governance and accountability were a must. In response, the Delta Reform Act was crafted and passed by the Legislature.

Senate Bill X7 1 — Delta Reform Act

In 2009, the Legislature passed a series of water-related measures that included the Delta Reform Act. The act established the coequal goals of a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem as overarching State policy and requires that the coequal goals be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. Furthermore, the act notably required that Californians reduce their reliance on the Delta.

A new governance structure was created by the Delta Reform Act. It created the Delta Stewardship Council (DSC), the Sacramento-San Joaquin Delta Conservancy (Delta Conservancy), and reshaped the Delta Protection Commission. The Legislature intended these three agencies to fulfill different, yet interrelated and complementary, roles in the protection and enhancement of the Delta. Additionally, a new Delta Watermaster position was created at the State Water Resources Control Board (SWRCB).

Delta Stewardship Council

The Delta Stewardship Council (DSC) is required to develop a comprehensive, legally enforceable direction for how the State manages important water and environmental resources in the Delta through the adoption of the Delta Plan. The DSC also ensures implementation of the Delta Plan through coordination and oversight of State and local agencies proposing to fund, carry out, and approve Delta-related activities. The Delta Reform Act also established the Delta Science Program within the DSC to ensure the appropriate use of science in Delta decision-making.

Delta Conservancy

The Delta Conservancy was established to act as a primary State agency to implement ecosystem restoration in the Delta and support efforts that advance environmental protection and the economic well-being of Delta residents. The Delta Conservancy is also directed to support efforts that protect, conserve, and restore the region’s physical, agricultural, cultural, historical, and living resources. The Delta Conservancy’s service area is the statutory Delta and Suisun Marsh.

Delta Protection Commission

The Delta Protection Commission is responsible for developing a long-term resource management plan for land uses within the primary zone of the Delta and is required by the Delta Reform Act to develop an economic sustainability plan for the Delta. The Delta Protection Commission’s goal is to ensure orderly, balanced conservation and development of Delta land resources and improved flood protection.

Delta Watermaster

The Delta Watermaster position was created to oversee the day-to-day administration of water rights, enforcement activities, and reports on water right activities regarding diversions in the Delta.

Unique Characteristics

The Delta is a unique place distinguished by its geography, Legacy Communities, a rural and agricultural setting, vibrant natural resources, and a mix of economic activities. The Legislature has found that the Delta’s uniqueness is particularly characterized by its hundreds of miles of meandering waterways and the many islands adjacent to them, and has described the Delta’s highly productive agriculture, recreational assets, fisheries, and wildlife as invaluable resources (CWC section 12981 (b)). The Delta Plan (DSC 2013) recognizes the following values that make the Delta a distinctive and special place:

- The Delta's geography of low-lying islands and tracts shaped by sloughs, shipping channels, and rivers, tidal influences, levees, and other water controls is unique among California landscapes.
- The Delta retains a rural heritage, characterized by farms and small towns linked by navigable waterways and winding country roads.
- The Delta's agricultural economy is vital to the region and to the state.
- The Delta is a region where maritime ports, commercial agriculture, and expanding cities coexist with a unique native ecosystem that is home to many species of wildlife and fish.
- The Delta is a place of ethnic tradition, Legacy Communities, and family farms.
- The Delta provides opportunities for recreation and tourism because of its unique geography, mix of opportunities, and rich natural resources.

Levee System

Without the levees, Delta land could not be used as it is today for highly productive farming, homes, and conveyance of fresh water to support other areas of the state. Delta levees provide a wide array of local, statewide, and nationwide benefits. Virtually all assets and attributes of the Delta, including many benefits that accrue to the state at large, are dependent upon the Delta levee system for flood protection. Levees protect land areas near and below sea level and provide a network of channels that direct movement of water across the Delta. California has significant interest in the benefits provided by the Delta and protected by the Delta levees.

Levees for Delta islands and tracts hold significant state interest due to protection provided to:

- Human life and public health.
- Personal property.
- Businesses.
- Significant wetlands, both natural and those created by waterfowl-friendly agricultural practices within the Pacific Flyway.
- Highways and railroads.
- Water supply aqueducts and pumping plants.
- River corridors that provide fish and wildlife migration and for conveyance of flood flows (Sacramento, Mokelumne, Cosumnes, and San Joaquin rivers).
- Transmission lines (electric and petroleum).
- Navigation and deep-water shipping.
- Water and wastewater treatment plants.
- Natural gas storage, production, and transmission.
- Water quality and water supply.
- Western islands that help repel salinity.
- Export water supply conveyance.
- Agriculture.
- Recreation.
- Cultural, historical, and aesthetic assets.
- Meandering waterways.

Some of these benefits are protected by Delta levees acting individually to prevent direct damage from flooding. Other benefits are protected by the levees functioning together to preserve the network of channels and land areas. Damage and interruption of service from critical infrastructure protected by some Delta levees can affect the state's economy and public health and welfare (DWR 2012).

In the Legal Delta, there are 980 miles of permanently maintained levees (DPC 2012). Of this total, 380 miles are project levees constructed or improved by the U.S. Army Corps of Engineers (USACE), 63 miles are urban non-project levees, and the remaining 537 miles are non-urban, non-project levees that need to be maintained and enhanced primarily by the State and the local reclamation districts. Of those 537 miles, 470 miles are "lowland" levees, which protect lands below sea level (DPC 2012). Lowland levees are critical to protecting water quality, the conveyance of water through the Delta, and protecting and enhancing the Delta as a place, whereas project and urban levees are fundamentally flood control levees.

Project levees are those levees that are part of the federal-State flood protection system in the Sacramento-San Joaquin Valley. These are levees of federally authorized projects for which the State has provided assurances of cooperation to the federal government and are considered part of the State Plan of Flood Control (SPFC). The SPFC represents a portion of the Central Valley flood management system for which the State has special responsibilities, as defined in the CWC Section 9110 (f). The SPFC Descriptive Document (DWR 2010) provides a detailed inventory and description of the levees, weirs, bypass channels, pumps, dams, and other structures included in the SPFC.

Constructed facilities in the Sacramento-San Joaquin Delta area include the extensive system of levees that provides flood protection to the 70 major islands and tracts, as well as improved channels, gates, and control structures that serve multiple purposes, including water supply conveyance, salinity control, and fisheries protection. An island-by-island list of project and non-project levees, as well as some of the major water facilities is available in the *California's Flood Future Report*.

Ecosystem

The Delta is a floodplain estuary that connects river to ocean and land to water. Floodplain estuaries are among the most productive ecosystems on the planet. The high productivity associated with floodplain estuaries is driven by the intimate relationship between land and water. However, compared to other estuaries, the Delta has very low levels of primary productivity in both the Suisun Marsh and the Delta.

Historically, the Delta consisted of hundreds of miles of tidally influenced sloughs and channels and hundreds of thousands of acres of marsh and overflow land. There were three primary landscapes within the Delta of the past: tidal freshwater wetlands interwoven with tidal channels dominated the Central Delta, flood basins bordered by broad riparian forests on the natural levees of the Sacramento River in the North Delta, and the three distributary branches of the San Joaquin River that supported a broad floodplain that gradually merged with tidal wetlands in the South Delta (Whipple et al. 2012). At one time, the Delta supported hundreds of species, including the grizzly bear, tule elk, and gray wolf. As land reclamation took place and levees were built, the ecosystem changed. More than 90 percent of the wetlands were converted to farms and more recently to urban uses (DWR 2009). The grizzly bear and gray wolf no longer reside in the Delta, but a population of tule elk has been established in the Suisun Marsh. The numbers of birds using the Delta have declined as well due to land reclamation, although changes in cropping patterns have allowed populations of some species to increase. Currently, the Delta and Suisun Marsh support more than 55 known fish species and more than 750 plant and wildlife species. Of these species, approximately 100 wildlife species, 140 plant species, and 13 taxonomic units of fish are considered special-status species and are afforded some form of legal or regulatory protection (DSC 2012).

The Suisun Marsh is the largest contiguous brackish water marsh remaining on the West Coast of North America and is a critical part of the Bay Delta estuary ecosystem. The Marsh encompasses more than 10 percent of California's remaining natural wetlands and serves as the resting and feeding ground for resident waterfowl and thousands of birds migrating on the Pacific Flyway, a major north-south route for migratory birds. The marsh also serves as a critical link for anadromous fish and is thought to be an important nursery for fish.

Land Use

The Delta is not a region unto itself. As noted previously, the Delta is made up of six counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo. The Delta Area, which includes the legal Delta and the Suisun Marsh, totals approximately 1,315 square miles or about 840,000 acres (URS/JBA 2008). Figure D-3 shows the county boundaries and the general land use in the Delta and Suisun Marsh.

PLACEHOLDER Figure D-3 County Boundaries and General Land Use

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Before 1850, the Delta was essentially a broad expanse of water-based habitat and natural channels. The Delta was a water highway between San Francisco and Sacramento and the Gold Country. The fastest and most direct means of travel between Sacramento and San Francisco was by ferryboat. Large-scale reclamation of the Delta for agriculture began in 1868, and by 1900, most of the lands with mineral-organic soils around the Delta's exterior were reclaimed. The final period of Delta reclamation occurred between 1900 and 1920 on lands in the Delta's interior. The result of these reclamation efforts is largely what is seen as the Delta today — approximately 700 miles of meandering waterways and 980 miles of levees protecting more than 538,000 acres of farmland, homes, and other structures (URS/JBA 2008).

Today, the Delta is dominated by highly productive agricultural land. The main crops grown in the Delta are corn, alfalfa, pasture, tomatoes and grapes. Historically, asparagus, corn, pasture, alfalfa, and sugar beets were the dominant crops. In addition to changes in crops, the amount of urban and natural protected lands has increased in the Delta, but agricultural lands have decreased.

The Delta was given a legal boundary (Section 12220 of the CWC) in 1959 with the passage of the Delta Protection Act (see Figure D-1). Anticipating the potential effects of urban development on the Delta, the original act was refined in 1992 to provide Primary and Secondary Zones within the previously defined Legal Delta and the development of a resource management plan for land uses within the Primary Zone. The Primary Zone (about two-thirds of the Delta area) was intended to remain relatively free from urban and suburban encroachment to protect agriculture, wildlife habitat, and recreation uses. Urban development in the Secondary Zone (the remaining one-third) was intended to include an appropriate buffer zone to prevent impacts on the lands in the Primary Zone.

Senate Bill X7-1 directs the Delta Protection Commission to prepare and submit to the Legislature recommendations regarding the potential expansion of or change to the Primary Zone of the Delta. The

Primary Zone Study was completed in 2010, but the Delta Protection Commission has not submitted any recommendations for changes to the Primary and/or Secondary Zones to the legislature.

The Delta Protection Commission updated the 1995 Resource Management Plan in 2010. Several policies and recommendations in the Land Use and Resource Management Plan for the Primary Zone of the Delta are applicable to the CWP. These include:

- Water Policy 1. “State, federal and local agencies shall be strongly encouraged to preserve and protect the water quality of the Delta both for in-stream purposes and for human use and consumption.”
- Water Policy 2. “Ensure that Delta water rights and water contracts are respected and protected, including area of origin water rights and riparian water rights.”

There has been significant population growth within the Legal Delta since 1990, almost entirely attributable to the expanding urban areas contained within the Secondary Zone. Specifically, the Secondary Zone contains an estimated 560,000 residents according to the *2010 Decennial Census*, up from about 360,000 in 1990, a 56 percent increase (the state as a whole increased by 25 percent during this period). In contrast, the *Census* reports roughly 12,000 residents living in the Primary Zone in 2010, about the same number as 20 years ago. Currently, the population within the Primary Delta represents about 2 percent of the Legal Delta’s total and this proportion appears to be shrinking (DPC 2012).

The Primary Zone encompasses about 67 percent of the Legal Delta’s total land area. It is a highly rural and sparsely populated area surrounded by relatively fast-growing urban areas in or adjacent to the Secondary Zone. A variety of interrelated factors are preventing growth in the Secondary Zone from spreading to the Primary Zone, most notably regulatory prohibitions, lack of public infrastructure, and economic feasibility. The relatively fast growth in the Secondary Zone is largely attributable to its role in accommodating spillover growth from large, land-constrained urban centers in the San Francisco, Sacramento, and Stockton metropolitan areas.

The Delta’s economy, like its population, is primarily urban and service oriented. However, the Delta Reform Act of 2009 and the Delta Protection Act of 1992 are primarily concerned with the natural resources of the Delta and the economic activity sustained by those resources such as agriculture and outdoor recreation. In addition, the resources of the Delta support significant water, energy, and transportation infrastructure that serves the Delta, regional and state economies, and an important commercial and recreational salmon fishery throughout the state.

The Stockton and Sacramento Deep Water Ship Channels were constructed in 1933 and 1963, respectively. Recent volume was 0.7 and 2.9 million metric tons in Sacramento and Stockton, respectively (DWR 2009). The Port of Sacramento has seen an average decline in tonnage since 1994. This is related to reductions in agricultural and forestry shipments, which were the mainstay of operations at the port. Cargo levels through the Port of Stockton have continued to grow, and in 2005, Stockton became the fourth busiest port in California, after Los Angeles, Long Beach, and Oakland. Both ports are currently investigating the use of barges to move goods between California’s coastal ports and the Central Valley.

Agriculture

Agriculture is among the qualities that define the Delta as a place. Creating farmland was the purpose for the Delta’s initial reclamation and for the maintenance of its levees and water controls. Agriculture benefits from the Delta's productive soils, special climate, and abundant water. Close to 80 percent of all farmland in the Delta is classified as Prime Farmland, the California Farmland Mapping and Monitoring Program's highest designated tier (DPC 2012). Because of the fertile peat soils and the moderating marine influence, Delta agriculture's per-acre yields are almost 50 percent higher than the state's average (Trott 2007).

The main crops grown in the Delta are corn, alfalfa, tomatoes, wheat, and wine grapes. In 2009, the total value of Delta crops was approximately $702 million. When related value-added manufacturing such as wineries, canneries, and dairy products are included, the statewide impact of Delta agriculture is 25,125 jobs, $2.135 billion in value added, and $5.372 billion in economic output (DPC 2012).

In addition to the economic value of agricultural lands, some lands provide rich seasonal wildlife habitat. Thousands of acres of agricultural lands are flooded after harvest and provide feeding and resting areas for resident and migratory birds and other wildlife. This practice of seasonal flooding helps maximize the wildlife values of agricultural areas and lessen opportunities for agricultural pests.

While agriculture is the primary land use in the Delta, the total area of agricultural lands in the combined Delta and Suisun Marsh area has declined from about 549,420 acres in 1984 to 460,450 acres in 2008 (DSC 2012). The continued viability of agriculture in the Delta will require the protection of sufficient farmland and fresh water to support commercially viable operations and provide ways for agriculture to coexist with habitat restoration.

Recreation

Recreation is an integral part of the Delta, complementing its multiple resources and contributing to the economic vitality and livability of the region. Residents of nearby areas visit virtually every day, generating a total of roughly 12 million visitor days of use annually and a direct economic impact of more than a quarter of a billion dollars in spending (DPC 2012). The region's mix of land and water offers diverse recreation experiences and facilities including fishing, boating, bird watching, other nature activities, hunting, enjoying restaurants, campgrounds, picnic areas, and visiting historic towns and buildings.

The California Department of Parks and Recreation prepared a Recreation Proposal for the Sacramento-San Joaquin Delta and Suisun Marsh in May 2011, which recommends enhancing California State Parks and other State agencies' properties and programs to create a network of recreation areas in the Delta and encourages improvement of public access along the shorelines of growing Delta communities. It recommends providing recreation improvements in new water management and habitat restoration projects where these are consistent with the projects' purpose. Future prospects for Delta recreation and tourism will be strongly influenced by decisions about the Delta ecosystem, water quality, levee improvements, and governance including land use and environmental standards. The Bay Delta Conservation Plan (BDCP), Delta water quality plans, levee investments, and other decisions yet to be made can all significantly affect recreation and tourism.

PLACEHOLDER Photo D-1 Recreating in the Delta

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Legacy Communities

The Delta Reform Act of 2009 (SB X7 1) identifies the Delta's Legacy Communities as Bethel Island, Clarksburg, Courtland, Freeport, Hood, Isleton, Knightsen, Rio Vista, Ryde, Locke, and Walnut Grove. Each community has its own character. Bethel Island is a recreation destination. Clarksburg and Courtland are centers for wine and pear production. Freeport and Hood were transportation centers with river landings and rail spurs to move goods. Locke and Walnut Grove had large Asian populations who worked at packing sheds and surrounding local farms. Ryde is known for its landmark hotel and Isleton is known for festivals and visitor-serving businesses. Rio Vista is the largest community and Knightsen is a small community known for several nearby horse ranches. All the Legacy Communities except Isleton and Bethel Island are in the Delta's Primary Zone.

Subsidence

The reclamation of Delta islands and their cultivation for agriculture initiated a process of land subsidence, mostly due to oxidation of peat soils, but also from wind erosion. Drainage and cultivation dried the saturated peat, reducing its volume by approximately 50 percent (Mount and Twiss 2005). Early cultivation practices also included burning, which further reduced the volume of the soil and altered its structure. Over time, long-term oxidation reduced about 2.6 to 3.3 billion cubic yards of these peaty soils to small particles and gases (DSC 2013). As a result, most of the central Delta today is below sea level, with some islands commonly 12 to 15 feet below sea level (see Figure D-4). Although subsidence has slowed in some areas, other regions of the Delta continue to lose soil to oxidation and wind erosion at a rate of 5 to 15 tons/acre/year (DSC 2013). It is projected that some areas of the Delta could subside an additional 2 to 4 feet by 2050 (Deverel and Leighton 2010).

PLACEHOLDER Figure D-4 Land Subsidence in the Delta

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Suisun Marsh

Historically, the Suisun Marsh consisted of 68,000 acres of tidally inundated islands separated by sloughs. Diking of Suisun Bay, primarily for livestock grazing, began around the mid-1860s. Shortly thereafter, the first duck clubs were established around the marsh ponds. By the early 1900s, livestock grazing was giving way to other agricultural activities. Eventually, increasing salinity and land subsidence caused agricultural activities to fail and be replaced by duck clubs. Levees originally constructed for farming are now an integral part of the infrastructure of the duck clubs (URS 2007).

The Suisun Soil Conservation District was formed in 1963, later named the Suisun Resource Conservation District (SRCD). The SRCD is a special district of the State that represents private landowners in the Suisun Marsh on a variety of issues at federal, State, and local levels. The goals of SRCD are to achieve water supply of adequate quality to promote preferred waterfowl habitat and retain wetland resource values through appropriate management practices.

In 1974, the Legislature passed the Nejedly-Bagley-Z'berg Suisun Marsh Preservation Act (SMPA). The act directed the San Francisco Bay Conservation and Development Commission (BCDC) and the California Department of Fish and Wildlife (DFW) to prepare the Suisun Marsh Protection Plan. The Suisun Marsh Protection Plan (SMPP), developed in 1976, includes a Primary Management Area (see

Figure D-1) encompassing 89,000 acres and a Secondary Management Area that includes approximately 22,500 acres of significant buffer lands. The SMPP calls for the preservation of Suisun Marsh, preservation of waterfowl habitat, improvement to water distribution and levee systems, and encouraging agriculture that is consistent with wildlife and waterfowl, such as grazing. The BCDC has land use and development permitting authority in the Primary Management Area. The SRCD has primary local responsibility for water management on privately owned lands in the Marsh.

In 2000, the CALFED Record of Decision (ROD) was signed, which included the Ecosystem Restoration Program (ERP) calling for the restoration of 5,000 to 7,000 acres of tidal wetlands and the enhancement of 40,000 to 50,000 acres of managed wetlands. In 2011, the Suisun Marsh Habitat Management, Preservation, and Restoration Plan was completed. This plan seeks to balance the needs of the CALFED ROD, the SMPA, and other plans by protecting and enhancing land uses, existing waterfowl and wildlife values, endangered species, and State and federal water project supply quality.

Currently, 90 percent of the wetlands in the Suisun Marsh are diked and managed as food, cover, and nesting habitat for thousands of birds migrating on the Pacific Flyway and resident waterfowl (SRCD 1998). The Suisun Marsh provides habitat for more than 221 bird species, 45 mammalian species, 16 reptile and amphibian species, and more than 40 fish species (ICF 2010). The tidal habitat in the marsh provides rearing areas for juvenile salmon, thus supporting the state’s commercial salmon fishery. The marsh levee system, comprised of approximately 200 miles of levees, contributes toward managing salinity in the Delta.

The balance of the Suisun Marsh is privately owned, with 158 individual waterfowl hunting clubs and numerous upland parcels for cattle grazing. The California Department of Fish and Wildlife (DFW) owns nearly 15,300 acres of managed and tidal wetlands. Urban encroachment has not occurred within the marsh, but conflicts and pressures are occurring with the increasing urbanization and industrialization up to the edges of the Suisun Marsh Secondary Management Area.

PLACEHOLDER Photo D-2 Suisun Marsh

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Tribal

Senate Bill 18 (Chapter 905, Statutes of 2004) requires cities and counties to consult with Native American tribes during the adoption or amendment of local general plans or specific plans. A contact list of appropriate tribes and representatives within a region is maintained by the Native American Heritage Commission. The following is a list of the tribes with historical or cultural ties to the Delta region, according to the commission.

- California Valley Miwok Tribe.
- Cortina Band of Indians.
- Ione Band of Miwok Indians.
- North Valley Yokuts Tribe.
- Rumsey Indian Rancheria of Wintun.
- Shingle Springs Band of Miwok Indians.
- The Ohlone Indian Tribe.

- United Auburn Indian Community of the Auburn Rancheria.
- Wilton Rancheria.

Unique Challenges/Drivers of Change

The Delta and Suisun Marsh ecosystem, as a large component of the San Francisco Estuary, was once one of the most biologically productive and diverse ecosystems on the West Coast, supporting a wide array of native plant and wildlife species and providing important habitat for many migratory species. The Delta ecosystem is now in peril. As a result of human activity to reclaim farmland, protect areas from flood, and provide water for agriculture and communities, discharge of wastes from agriculture, industry, and urban areas, and the introduction of harmful invasive species, the Delta has been modified in ways that adversely influence ecosystem function and compromise its ability to support a healthy ecosystem. These changes not only affect the species that live there, but also the ecosystem services that benefit humans, such as improved water quality, agricultural productivity, healthy commercial and sport fisheries, flood protection, and recreation.

One example of the decline of the Delta ecosystem is the pelagic organism decline (POD). Abundance indices calculated by the Interagency Ecological Program (IEP) through 2007 suggest marked declines in four pelagic fishes in the upper San Francisco Estuary (the Delta and Suisun Bay). These fishes include delta smelt, which is listed under State and federal Endangered Species Acts as endangered and threatened, respectively and the longfin smelt protected under California's Endangered Species law as a threatened species. Although the numbers had historically fluctuated, this steep and lasting dropoff signaled an ecological crisis.

There are many factors and actions that have stressed the Delta ecosystem and collectively are termed "stressors." The Delta Independent Science Board categorized these stressors into broad groups to assist in evaluating management options. These categories include current stressors, legacy stressors, globally determined stressors, and anticipated stressors. The current stressors in the Delta identified in the Delta Plan are altered Delta flow, habitat degradation and loss, impaired water quality, non-native species, and hatcheries and harvest management (DSC 2013). Additionally, the Delta faces other unique challenges that will influence efforts to address the declining ecosystem, such as the need for water supply reliability, flood risk, and climate change.

Altered Delta Flows

Native species are adapted to the seasonal, inter-annual, and spatial variability of the historical flow pattern and the functions that come with it. Flow interacts with land to create physical habitats and connections where species find food, refuge, and reproduction space. Through a variety of mechanisms, native species can survive, grow, and reproduce better when flows occur in more natural historical patterns.

Present-day Delta flows are very different from historical, natural flows. Water flows have been altered by water supply and flood control structures and draining of floodplains, wetlands, and groundwater basins. Current flow management regulations provide some protection for ecological functions and native species, but the current Delta flow regime is generally harmful to many native aquatic species while encouraging non-native aquatic species (SWRCB 2010).

Habitat Degradation and Loss

Much of the original habitat for the Delta's native fish, wildlife, and plants has been urbanized or converted to agriculture over the last 160 years (Healey et al. 2008; Moyle et al. 2010; Baxter et al. 2010). The current Delta ecosystem continues to be productive, but its habitat types and conditions support a much different mix of species that the historical Delta and many of the currently thriving species are non-native. Inadequate habitat for native species that reside in and migrate through the Delta is an important current ecosystem stressor that is affected by and interacts with many other stressors.

Impaired Water Quality

The location, extent, and dynamics of the freshwater-saltwater interface in the Bay Delta is an important factor in the distribution and abundance of many fish, invertebrate, and plant species, and is largely determined by the amount of fresh water flowing from the Delta west into Suisun Bay. The Delta ecosystem is also affected by a variety of pollutants discharged into Delta and tributary waters. Pollutants of concern affecting Delta biological species and ecosystem processes include nutrients, pesticides, mercury, selenium, and other persistent bioaccumulative toxic substances. More detail on how these constituents affect the Delta can be found under the Water Quality section.

Non-native Species

Non-native species in the Delta create a wide range of stresses on native species. They have altered food webs and habitats, they compete with native species for resources, and they prey directly upon native species. Non-native species have been introduced into the Delta over time via watercraft, fishing gear, live bait intentionally (either legally or illegally) introduced for recreational or other purposes, or released from aquariums into the environment (DFG 2011).

Introduced species now dominate all habitats in the Delta. Among the introduced species of the Delta, the most visible is the aquatic weed *Egeria densa*, which often fills low-velocity channels in the Central and Southern Delta and reduces water turbidity. Two clams from Asia dominate the benthos of the Delta: the Asian clam, *Corbicula fluminea*, is most abundant in fresh water, and the overbite clam, *Corbula amurensis*, is abundant in brackish-to-saline water. Striped bass and largemouth bass, both deliberate introductions, are not only among the most abundant fish of pelagic and near-shore habitats, they are also predatory and probably have a negative effect on native species.

Another invasive species, water hyacinth, *Eichhornia crassipes*, showed up in California more than 100 years ago. Water hyacinth was first reported in California in 1904 in a Yolo County slough. There were increased reports of water hyacinth in the Delta region during the 1970s. By 1981, water hyacinth covered 1,000 acres of the Delta and 150 of the 700 miles of waterways (CDBW 2009). Water hyacinth can rapidly dominate a waterway, impede drainage, foul water pumps, and block irrigation channels. It changes water quality and displaces native vegetation used for food or shelter.

Impacts of Hatcheries and Harvest Management

Hatcheries can introduce diseases to wild fish populations and alter their genetic makeup, thus affecting their ability to perform in the wild. Inappropriate or insufficient fishing regulations and practices also can have wide-ranging effects, from overfishing that reduces genetic diversity to food web and ecological changes.

Need for Water Supply Reliability

Over the past several decades, increasing demand for the Delta's resources have increased the conflict between the needs of water users and efforts to sustain the estuary's aquatic ecosystem and support recovery of State and federally listed fish. These conflicts have led to a crisis regarding the ability to protect Delta fisheries, maintain water quality, and meet the needs of both in-Delta and export area agricultural and municipal water users. This situation has resulted in the need to address these competing beneficial uses and sustainability concerns.

Delta export reliability hinges on first satisfying water quality requirements for native Delta fish and the criteria for in-Delta flow and water quality standards. The in-Delta water quality conditions will fluctuate with seawater intrusion, the quality and quantity of river and small stream inflows, in-Delta water management operations, and export pumping operations. Required inflows to the in-Delta ecosystem will also depend on the health of indigenous species and invasive species management actions.

Existing Delta conveyance does not provide long-term reliability to meet current and projected needs. Conveyance through the Delta in times of drought is especially challenging considering the various demands from agriculture, municipalities, and environmental needs. To improve through-Delta conveyance water supply reliability and provide greater operational flexibility, improvements to existing facilities in the form of updating aging infrastructure, upgrading existing capacities, adding redundancy to the system and constructing additional facilities may be needed.

The major issues pertaining to reliability of water supply transferred through the Delta include the following items.

- The health of the Delta ecosystem is paramount in consideration of water-related activities within the Delta. Continuing declines in some native species populations migrating through or living in the Delta, such as salmon and delta smelt, highlight the increasing influence of the Delta ecosystem on water supply reliability. Any activity proposed for Delta conveyance will need to consider the restoration and preservation of native habitat to benefit pelagic organisms and other native species.
- The integrity of Delta levees is continually undermined by such elements as storm events creating floods and seawater surges, island subsidence, natural levee erosion, poor quality peat soils used to build the original levees, seismic activity, burrowing animals, and sea level rise. These vulnerabilities call into question the long-term sustainability of using the Delta as a conveyance corridor.
- Maintaining water quality within the Delta for both drinking water and for native species habitat will be a challenge. Constituents of concern include, but are not limited to, salinity, bromide, chloride, organic carbon, nutrients, pathogens, dissolved oxygen (DO), temperature, and turbidity. Control of water quality in a tidal estuary with seasonal and yearly fluctuating hydrology will require well-understood and fully inclusive strategies. As water quality requirements can vary and at times conflict among users, the challenge will be to agree upon the implementation strategy.
- Maintenance of in-Delta projects for beneficial uses such as recreational boating and swimming, sport fishing, shipping, and agriculture, industrial, and drinking water supply will be an ongoing management challenge as political and fiscal climates evolve and resources for competing priorities become more scarce.

Flood Risk

Land reclamation in the Delta began in the 1850s by construction of levees, resulting in today's complex labyrinth of islands and waterways that are protected from flooding by these levees. Many of the Delta levees were initially constructed more than a century ago using primitive materials and equipment and without the benefit of today's engineering standards. Levee failures occur as a result of large runoff events, extreme high tides, wind-generated waves, earthquakes, land subsidence, sea level rise, or burrowing activities. The consequent flooding of a Delta island can increase the risk of levee failures on adjacent islands.

From a flooding viewpoint at least 75 percent of the Delta area, more than 78 percent of its cropland, and over 210,000 people are exposed to a 500-year flood event (DWR 2013). In addition, a catastrophic-level failure in the Sacramento-San Joaquin Delta would endanger a major source of water supply for 27 million California residents and approximately 3 million irrigated acres of farmland (DSC 2013). Major issues related to flood management facing the Delta are the impacts of climate change, sea level rise, subsidence, levee maintenance and certification, and impacts of development. Major floods occur regularly in the Sacramento-San Joaquin Delta area. Some urban and small-stream flooding occurs in every large storm. Floods during winter storms that cause high-water surface elevations and have strong winds have been a common cause of levee failures in the Delta. For example, the flows of the Sacramento River at Rio Vista during winter and early spring are often 30 times greater than the typical late-summer flows. High water in the Delta can overtop levees, as well as increase the hydrostatic pressure on levees and their foundations, which causes instability and increases the risk of failure due to through-levee and/or under-levee seepage.

Climate Change

For more than two decades, the State and federal government have been preparing for climate changes effects on natural and built systems with a strong emphasis on water supply. Climate change is already impacting many resource sectors in California including water, transportation and energy infrastructure, public health, biodiversity, and agriculture (USGRCP 2009; CNRA 2009). Climate model simulations, based on the Intergovernmental Panel on Climate Change's 21st Century Climate Scenarios, project increasing temperatures in California with greater increases in the summer. Projected changes in annual precipitation patterns in California will result in changes to surface runoff timing, volume, and type (Cayan 2008). Recently developed computer downscaling techniques indicate that California flood risks from warm-wet atmospheric river type storms may increase beyond those that has been known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011).

Currently, enough data exists to warrant the importance of contingency plans, mitigation (reduction) of greenhouse gas (GHG) emissions, and incorporating adaptation strategies, methodologies, and infrastructure improvements that benefit the region at present and into the future. While the State is taking aggressive action to mitigate climate change through GHG reduction and other measures (CARB 2008), global impacts from carbon dioxide and other GHGs that are already in the atmosphere will continue to impact climate through the rest of the century (IPCC 2007).

Resilience to an uncertain future can be achieved by implementing adaptation measures sooner rather than later. Because of the economic, geographical, and biological diversity of the state, vulnerabilities and risks due to current and future anticipated changes are best assessed on a regional basis. Many resources are available to assist water managers and others in evaluating their region-specific vulnerabilities and identifying appropriate adaptive actions (EPA/DWR 2011; Cal-EMA and CNRA 2012).

Observations

Climate change impacts observed in California in the past 100 years include an increase in average temperatures of approximately one degree F, a decrease in the average early snowpack in the Sierra Nevada of about ten percent, and a rise in the mean sea level at Golden Gate Bridge in San Francisco Bay of seven inches (DWR 2008). Regionally, based on data from the Western Regional Climate Center, mean temperatures have increased about 1.5 to 2.4^{o}F (0.8 to1.3^{o}C), with minimum values increasing more than maximums [2.1 to 3.1^{o}F (1.2 to 1.7^{o}C) and 0.7 to 1.9^{o}F (0.4 to 1.1^{o}C)], respectively.

Projections and Impacts

While historic data is a measured indicator of how the climate is changing, it can't project what future conditions may be like under different GHG emission scenarios. Current climate science uses modeling methods to simulate and develop future climate projections. A recent study by Scripps Institution of Oceanography uses the most sophisticated methodology to date and indicates that by mid-century (2060-2069) temperatures will be 3.4 to 4.9 ^{o}F (1.9 to 2.7 ^{o}C) higher across the state than they were from 1985 to 1994 (Pierce et al. 2012). For the Delta region, the study projects that annual temperatures will increase by approximately 4.1^{o}F (2.3 ^{o}C), with a 3.1^{o}F (1.7 ^{o}C) increase in winter temperatures and a 5.2 ^{o}F (2.9 ^{o}C) in summer temperatures. Climate projections for the Delta region from Cal-Adapt indicate that the temperatures between 1990 and 2100 will increase by as much as 6 to 7 ^{o}F (3.3 to 3.9 ^{o}C) in the winter and by 7 to 9 ^{o}F (3.9 to 5 ^{o}C) in the summer (Cal-EMA and CNRA 2012).

Changes in annual precipitation across California, either in timing or total amount, will result in changes in type of precipitation (rain or snow) in a given area and to surface runoff timing and volume. Most climate model precipitation projections for the state anticipate drier conditions in Southern California, with heavier and warmer winter precipitation in Northern California. More intense wet and dry periods are anticipated which could lead to flooding in some years and drought in others. Extreme precipitation events are projected to increase with climate change (Dettinger 2011). Since there is less scientific detail on localized precipitation changes, there exists a need to adapt to this uncertainty at the regional level (Leung 2012). In addition, mean sea levels are projected to rise about 12 inches by 2050 and as much as 67 inches by 2100 (NRC 2012). Lying at the confluence of two major rivers, the Delta region is particularly vulnerable to the impacts of these changes.

The major rivers draining into the Delta region originate in the Cascade Range to the north and the Sierra Nevada range to the east and are fed primarily by snowmelt. Winter air temperatures in these mountain ranges are projected to increase by 4 to 8^{o}F by 2100 (Cal-EMA and CNRA 2012). The Sierra Nevada snowpack is expected to continue to decline as warmer temperatures raise the elevation of snow levels, reduce spring snowmelt, and increase winter runoff. DWR projects that the Sierra Nevada will experience a 25-40 percent reduction of snowpack from its historic average by 2050 (DWR 2008). The higher winter runoff may contribute to increased stress on Delta levees and shorten seasonal inundation of floodplains. Lower flows in the summer and fall could increase water temperatures, reduce water quality, and result in greater salinity intrusion. These changes could contribute to biodiversity shifts, loss of agricultural productivity, and additional pumping restrictions.

Precipitation is also expected to become more variable with more extreme wet and dry conditions. Larger storm events in the Delta will put additional stress on the levees and contribute to more frequent levee failures. Levee failures can result in the direct loss of life and property and also disrupt important services or transportation corridors. It can also result in salinity intrusion, reducing agricultural productivity in the region, and disrupt SWP and CVP operations. Longer periods of drought could impact the region as well. Lower flows into the Delta will contribute to increased water temperatures, greater salinity intrusion, and reduced water quality putting greater stress on the ecosystem, reducing agricultural productivity, and impacting SWP and CVP operations.

In addition to these changes, land surfaces in the Delta are subsiding increasing the region's vulnerability to sea level rise. A 55 inch rise in mean sea level would increase the amount of land vulnerable to a 100-year flood event, though the amount varies throughout the region. Models project that 14 percent of the acreage in Solano County would be more vulnerable to a 100-year flood event. However, that number increases to 40 percent in Contra Costa County and up to 59 percent in Sacramento County (Cal- EMA and CNRA 2012). In addition to higher flood risk due to storm events, rising sea levels will inundate low lying areas and increase salinity intrusion into the Delta. The potential impacts to the region include an increase in the risk of levee failure, loss of agricultural land and productivity, loss of wetlands, reduced water quality due to salinity intrusion, contamination of groundwater supplies, more water dedicated to meeting water quality standards, biodiversity shifts, increased vulnerability to invasive species, and changes to SWP and CVP operations.

The Delta region is economically dependent on the thriving agricultural industry, which will be affected by a more variable hydrologic regime, salinity intrusion, increased levels of pests and disease, increased evapotranspiration, and other indirect effects of rising temperatures. In some instances, a longer growing season will be beneficial, but productivity of some crops may decline.

Regional Resource Management Conditions

Environmental Water

A diverse set of conditions in the Delta helped shape a unique ecosystem from which hundreds of aquatic species, many endemic to the system, evolved. Alterations to this system from the activities of reclaiming and maintaining the Delta for agriculture, urban areas, transportation corridors and utilities and managing the Delta as a water conveyance and supply system continue to challenge management of the system for the benefit of the ecosystem.

Since development within the Delta began, operation and management of the water conveyance and supply system has continually evolved. History suggests that many of the management adjustments and changes that have been made over the years within the Delta have fallen short in addressing the environmental or water quality concerns these actions were designed to resolve.

Requirements of the State Water Resource Control Board (SWRCB) and the biological opinions for endangered species largely determine requirements for water quality, flow, and CVP/SWP project operations in the Delta and Suisun Marsh. On occasion, the SWRCB requirements are superseded by requirements set by other agencies such as the U.S. Fish and Wildlife Service (USFWS). For example, in their middle 1990s *Delta Smelt/Sacramento Splittail Biological Opinions*, the USFWS set CVP/SWP operational criteria, which were ultimately folded into the SWRCB's decision, D-1641. Further, requirements outlined in contractual agreements, such as those between DWR and the North Delta Water Agency, play a role in Delta water quality, flow, and CVP/SWP project operations.

The SWP and the CVP coordinate project operations to maintain the standards established by D-1641 and the biological opinions by releasing water from upstream reservoirs for in-Delta as well as Delta outflow requirements, curtailing export pumping at the SWP Banks and CVP Tracy Pumping Plants during specified time periods, and meeting salinity standards in the Suisun Marsh. A sampling of requirements imposed on project operations are further described in the subsequent Project Operations section.

Ecosystem Restoration

This section describes the major plans and programs related to ecosystem restoration in the Delta and Suisun Marsh.

Ecosystem Restoration Program Conservation Strategy for Restoration of the Sacramento-San Joaquin Delta Ecological Management Zone and the Sacramento and San Joaquin Valley Regions

The DFG Conservation Strategy describes future restoration priorities and actions of the Sacramento-San Joaquin Delta, and the Sacramento Valley and the San Joaquin Valley regions. It further provides the conceptual framework and process that will guide the refinement, evaluation, prioritization, implementation, monitoring, and review of ERP actions. The Conservation Strategy can be found at http://www.dfg.ca.gov/erp/reports_docs.asp.

Suisun Marsh Habitat Management, Preservation, and Restoration Plan

The Suisun Marsh Habitat Management, Preservation, and Restoration Plan is a comprehensive plan designed to address the various conflicts regarding use of marsh resources. The focus is on achieving an acceptable multi-stakeholder approach to restoring 5,000 to 7,000 acres of tidal wetlands and the management of managed wetlands and their functions that are consistent with the CALFED program, the Suisun Marsh Preservation Agreement, applicable species recovery plans, and other interagency goals. The plan is at http://www.dfg.ca.gov/delta/suisunmarsh/.

Fish Restoration Program Agreement

The Fish Restoration Program Agreement (FRPA), between DFW and DWR, was signed on October 18, 2010. FRPA addresses specific habitat restoration requirements of the USFWS and the National Marine Fisheries Service (NMFS) biological opinions (Biological Opinions) for SWP and CVP operations. FRPA is also intended to address the habitat requirements of the DFW Longfin Smelt Incidental Take Permit (ITP) for SWP Delta operations. The primary objective of the FRPA program is to implement the fish habitat restoration requirements and related actions of the Biological Opinions and the ITP in the Delta, Suisun Marsh, and Yolo Bypass and is focused on 8,000 acres of intertidal and associated subtidal habitat to benefit delta smelt, including 800 acres of mesohaline habitat to benefit longfin smelt, and a number of related actions for salmonids. The Implementation Plan for FRPA is at http://www.water.ca.gov/environmentalservices/frpa.

Bay Delta Conservation Plan

The Bay Delta Conservation Plan is a planning process intended to result in the issuance of permits from DFW under the Natural Community Conservation Planning Act and from the USFWS and the NMFS pursuant to Section 10 of the federal Endangered Species Act. The BDCP proposes to contribute to the restoration of the health of the Delta's ecological systems by contributing to a more natural flow pattern than existing conditions in the Delta and by implementing a comprehensive restoration program. As currently proposed (BDCP 2013), the BDCP seeks to restore and protect approximately 145,000 acres of aquatic and terrestrial habitat over its 50-year term. More information on the BDCP is at http://baydeltaconservationplan.com/Home.

Local Habitat Conservation Plans and Natural Community Conservation Plans

Several locally sponsored Habitat Conservation Plans (HCP) and Natural Community Conservation Plans (NCCP) are in place or under development in the Delta. These plans propose to allow for economic activities in the Delta to continue while minimizing and mitigating the impact of authorized incidental take of the endangered or rare species that the plans cover and to conserve these species and their habitats. Completed plans in the Delta include the San Joaquin HCP and East Contra Costa HCP/NCCP. The BDCP, Yolo County HCP/NCCP, South Sacramento HCP, and Solano Multispecies HCP are still being developed.

Sacramento-San Joaquin Delta Conservancy

In 2009, the Legislature established the Delta Conservancy to act as a primary State agency to implement ecosystem restoration in the Delta and to support efforts that advance environmental protection and the economic well-being of Delta residents. The Delta Conservancy Strategic Plan was adopted in June 2012. More information on the Delta Conservancy is at http://www.deltaconservancy.ca.gov/.

Delta Levees Special Flood Control Projects

DWR's Delta Levees Special Flood Control Projects program provides funding to local agencies in the Delta for habitat projects linked to flood management improvements. Similarly, the 2012 Central Valley Flood Protection Plan proposes new or enhanced flood bypasses, levee setbacks, and fish passage improvements that provide both flood risk reduction and habitat. More information on the Delta Levees Special Flood Control Projects program is at http://www.water.ca.gov/floodsafe/fessro/levees/special_projects/special_projects.

Water Supplies

In an average water year like 2000, the largest source of water was the Sacramento River, which transported a little more than 21 maf (million acre-feet) into the Delta (DWR 2009). Additional flows from the San Joaquin River, and eastside tributaries such as the Mokelumne and Cosumnes rivers contributed just over 3.9 maf, with precipitation directly on the Delta adding about another 1 maf (DWR 2009). Freshwater flows in the Delta are typically much less than those caused by tides. In addition to precipitation-derived runoff, Pacific Ocean tides move into and out of the Delta, twice a day. Tidal rise and fall varies with location, from less than one foot in the eastern Delta to more than five feet in the western Delta.

A sizable amount of water from the Delta's watershed is diverted upstream and used before it reaches the Delta as Figures D-5 and D-6 illustrate. Figure D-5 depicts historical diversions from the Delta. Figure D-6 shows historical diversions before the Delta, in-Delta uses, and exports and outflows to the ocean.

PLACEHOLDER Figure D-5 Historical Diversions from within the Delta

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

**PLACEHOLDER Figure D-6 Historical Diversions before the Delta,
In-Delta Uses and Exports from the Delta, Plus Outflows**

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

The Suisun Marsh is a brackish marsh. Salinities vary seasonally with higher salinities in the summer and fall, and lower salinities in the winter and spring. There is always an east-to-west salinity gradient in the Suisun Marsh. During periods of local rainfall, numerous creeks provide fresh water inflow to the northern areas of the marsh, seasonally decreasing the salinities of these regions. These creeks are Denverton, Union, Laural, Ledgewood, Suisun, Green Valley, Jameson Canyon, and American Canyon.

Groundwater supplies in the Primary Zone of the Delta are continually recharged due to flows in Delta channels and the soft, absorbent soils of Delta islands. The water table is relatively shallow. A number of groundwater basins/subbasins touch on the Secondary Zone including the Sacramento Valley/Solano subbasin, San Joaquin Valley/Eastern San Joaquin and Tracy subbasins, and the Suisun-Fairfield Valley basin. Groundwater levels in most basins have declined as a result of agricultural and urban development. The Eastern San Joaquin subbasin has been characterized as being severely overdrafted with significant depressions east of Stockton and Lodi. Groundwater levels fluctuate with droughts, development, delivery of surface waters to the region, and periods of wet years.

Water Balance

A water balance is a good way to get an overview of the major flows into and out of the Delta. Three recent years 1998 (wet year), 2000 (average year), and 2001 (dry year) demonstrate typical fluctuations in Delta inflows/outflows. Figure D-7 shows Delta inflows/outflows for years 1998, 2000, and 2001. During these years, the water system was generally operated under the same rules as today. Some observations that can be made by looking at these three types of water years are:

- In-Delta consumptive use is similar most years.
- Water export quantities show more variability, but still are in a relatively narrow range.
- The widest variability from year to year occurs in the outflow from the Delta. Net outflow to the bay/ocean in a wet year can be many times more than the outflow during a dry year.
- Water diversions and exports are a larger portion of the Delta inflow during a dry year.

PLACEHOLDER Figure D-7 Delta Water Balance for Years 1998, 2000, and 2001

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

The historical records show even larger flow ranges than represented in Figure D-7. For example, during water year 1983 (October 1982 through September 1983), more than 60 (maf) of water passed through the Delta to the San Francisco Bay (see Figure D-6). By comparison, during water year 1977, which was one of the most severe drought years on record, only about 5 maf passed through the Delta to the San Francisco Bay (see Figure D-6).

Water Rights

Riparian water rights are entitlements to water that are held by owners of land bordering natural flows of water. A landowner has a right to divert a portion of the flow for reasonable and beneficial use on their land within the same watershed. Natural flows do not include return flows from use of groundwater, water stored and later released (e.g., by the State Water Project (SWP) or the Central Valley Project (CVP) for Delta export), or water diverted from another watershed.

Appropriative rights are held in the form of conditional permits or licenses from the SWRCB. Appropriative rights can be applied to both riparian and non-riparian lands provided the riparian rights on a given stream are satisfied first. Additionally, whether an appropriative right was initiated before or after 1914 affects the priority and legal history of the right and thus the regulation of the right.

A body of water rights law includes the area of origin, county of origin, watershed of origin, and Delta protection statutes. These laws were developed to retain the priority to subsequent appropriative uses within an area, county, or watershed, as against out-of-basin permitted appropriations. Specifically, they were enacted to protect local water users from appropriations by the CVP and SWP for use in areas outside the area of origin or the areas immediately adjacent to the areas of origin. Thus, area of origin statutes consist of a priority right to satisfy current uses, as well as a prospective priority right to satisfy future beneficial uses within a specifically identified geographic area.

The Delta Protection Act (1959) incorporates the area of origin protection to the Delta. Specifically, the act declares as a policy of the State "that no person, corporation or public or private agency or the State or the United States should divert water from the channels of the Sacramento-San Joaquin Delta to which the users within said Delta are entitled."

Contract Rights

The SWRCB authorizes and regulates diversion and export of water from the Delta by the SWP and CVP. The SWRCB first issued water rights permits to Reclamation for the operation of the CVP in 1958 (Water Rights Decision 893) and to DWR for operation of the SWP in 1967 (D-1275 and D-1291). Entitlements to these surface water supplies can be obtained through contracting with the SWP and the CVP. The CVP and SWP contractors have contractual rights as specified in the contracts. DWR has also entered into water supply contracts with water agencies in the Delta such as the North Delta Water Agency (NDWA). The NDWA contract provides assurances that users within the NDWA boundary have the right to divert water of a suitable quality to meet the reasonable and beneficial uses for agricultural, municipal, and industrial purposes.

Groundwater Rights

In most areas of California, overlying landowners may extract percolating groundwater and put it to beneficial use without approval from the SWRCB or a court. California does not have a permit process for regulating groundwater use. In several basins, however, groundwater use is subject to regulation in accordance with court decrees adjudicating the groundwater rights within the basins.

The California Supreme Court decided in the 1903 case *Katz v. Walkinshaw* that the "reasonable use" provision that governs other types of water rights also applies to groundwater. Prior to this time, the English system of unregulated groundwater pumping had dominated, but it proved to be inappropriate to California's semiarid climate. The Supreme Court case established the concept of overlying rights, in which the rights of others with land overlying the aquifer must be taken into account. Later court decisions established that groundwater may be appropriated for use outside the basin, although appropriator's rights are subordinate to those with overlying rights. A general overview of groundwater rights in California is on the SWRCB Web site at http://www.waterboards.ca.gov/waterrights/board_info/water_rights_process.shtml.

Water Uses within the Delta

Surface Water

Water use in the Delta region is mostly agricultural. Irrigation water is taken directly from the channels and sloughs through approximately 1,800 diversions, which together divert up to 5,000 cubic feet per second (cfs) during peak summer months. Though the primary water users in the Delta are individual farming operations, formal institutions have been established to manage Delta water. For instance, in November 1965, DWR and the U.S. Bureau of Reclamation reached agreement with some Delta interests on the quality of agricultural water to be maintained by the SWP and the CVP at various locations in the Delta. There was, however, no legal entity to sign the related contracts. As a result, the Legislature created the Delta Water Agency. This agency was replaced with three separate agencies in 1973 — the North Delta Water Agency, the Central Delta Water Agency, and the South Delta Water Agency. Contra Costa Water District, East Contra Costa Irrigation District, Byron-Bethany Irrigation District, the city of Antioch, and various industrial corporations are the remaining local water users within the Delta.

Most Delta farms use water under riparian and appropriative water rights, and drainage water from the islands is pumped back into the Delta waterways. In 2000, Delta agriculture used about 1.3 maf of water to irrigate about 476,000 acres of crops (Tully and Young 2007). In-Delta residential water is generally drawn through private wells or provided through community public water systems, such as the Contra Costa Water District. The remaining portion of water in the Delta is either used by the various forms of evapotranspiration or contributes to Delta outflow, which it provides wildlife habitat and salinity control benefits. Recreation water uses do not have a large effect on the Delta water balance, but are still important in the Delta.

Most Suisun Marsh managed wetlands begin flooding in the fall around October 1 in preparation for the fall migration of waterfowl. At the end of waterfowl season, water manipulation for habitat development may continue through July. Typically, the water remaining in the wetlands is drained in June or July to allow vegetative growth and to perform routine maintenance activities, such as repair of water control structures and levee maintenance, during the summer work season.

Power generation plants at Antioch and Pittsburg are cooled with water diverted from the Delta. Combined, the two power plants' pumps can divert 3,240 cfs. The SWP's North Bay Aqueduct (NBA) and the CVP's Contra Costa Canal deliver water to Bay Area cities. In 2010, the SWP diverted about 43,000 af (acre-feet) into the NBA and Contra Costa Water District withdrew about 94,000 af.

Groundwater

There is little known about groundwater use from the basins within the Delta's Secondary Zone with the exception of the East San Joaquin subbasin. Various estimates place groundwater use in the East San Joaquin subbasin at 730,000 to 800,000 af per year. The CALFED Programmatic EIS/EIR (2000) estimated that average annual groundwater withdrawals range from 100,000 to 150,000 af in upland areas of the Delta.

Recycled Water

According to the 2009 Municipal Wastewater Recycling Survey, compiled by the SWRCB, 9,115 af/yr are being recycled in the Delta. Most of the recycled water was used for agricultural irrigation or for wetlands and natural systems (SWRCB 2011a). State policy (SWRCB 2009) encourages increased use of recycled water, but recognizes the potential of recycled water to contribute to exceeding or threatening to exceed water quality objectives due to salt and nutrients. Therefore, the policy requires stakeholders to work together to develop salt and nutrient management plans. The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is a strategic initiative to address problems with salinity and nitrates in the surface waters and ground waters of the Central Valley.

Water Uses Outside the Delta

About half the state's runoff, which originates in the Sierra Nevada, flows through the Delta watershed. Many diversions in the Delta watershed occur in the upper watershed. On average, approximately 31 percent of the flow from the Delta watershed is diverted before it ever reaches the Delta (California Natural Resource Agency 2010). Some of the water diverted from the Delta tributaries is returned to the tributaries through wastewater effluent and agricultural return flows, albeit at a degraded quality.

Diversions from the Delta, first by the CVP in the 1950s and then by the SWP starting in the 1960s, have steadily increased over the years. The SWP provides water primarily to urban areas, but also supplies some water for agricultural uses, including the Kern County Water Agency. The SWP has contracts to deliver 4.2 million af annually. The CVP has contracts to deliver 3.1 million af annually from the Delta. The projects generally are not able to deliver their full contract amounts because the projects are also operated for Delta water quality requirements and fish protections. On average, the projects together have exported about 5 million af annually.

Project Operations

The CVP Delta facilities include the Contra Costa Canal (CCC), the C.W. "Bill" Jones Pumping Plant, the Tracy Fish Collection Facility, the Delta Mendota Canal (DMC), and the Delta Cross Channel Canal (DCC). The CCC and DMC convey water from the Delta to Contra Costa County and the DMC and San Luis service areas. The DCC is a controlled diversion channel between the Sacramento River and Snodgrass Slough. The C.W. "Bill" Jones Pumping Plant's diversion capacity is about 4,600 cfs.

The SWP facilities in the Delta include the North Bay Aqueduct (NBA), Clifton Court Forebay (CCF), John E Skinner Fish Facility, the Harvey O. Banks Pumping Plant, the Suisun Marsh Salinity Control

Gates (SMSCG), several Suisun Marsh distribution systems (Roaring River and Morrow Island) and up to four temporary barriers in the South Delta. The NBA conveys water to Napa and Solano Counties, and its maximum pumping capacity is 175 cfs. The CCF, Skinner Fish Facility, and Banks Pumping Plant divert and convey water to SWP service areas south of the Delta including the South Bay. Daily diversions into the CCF are governed by an agreement with the USACE (Public Notice 5820A). While the pumping capacity of Banks Pumping Plant is 10,500 cfs, the current permitted average daily diversion at CCF is 6,680 cfs. The SMSCG are operated to meet marsh water quality standards. The Suisun Marsh water distribution systems are designed to provide lower salinity water to public and privately managed wetlands and to discharge drainage water. Figure D-8 shows the locations of SWP and facilities.

PLACEHOLDER Figure D-8 Location of State Water Project and Central Valley Project facilities in the Delta-Suisun Area

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

As noted in the Environmental Water section, the operations of the SWP/CVP are subject to many State and federal laws, agreements, biological opinions, contract requirements, flood operations, etc. that are designed to protect water quality, water supplies, wetlands, anadromous and native fisheries, migratory birds, threatened and endangered species, and to prevent flooding, etc. Table D-2 (Laws, Directives, and Orders Affecting CVP and SWP Operations) lists several of these operational criteria and provides a summary description. An overview of several key actions is provided below:

- **Coordinated Operations Agreement.** The CVP and SWP release previously stored water into the Delta where they redivert the stored water and also divert natural flow to users mainly south and west of the Delta. The CVP and SWP use the Delta as a common conveyance facility. Reservoir releases and Delta exports must be coordinated to ensure that each project achieves its share of water supplies and bears it share of obligations to protect resources.
- **Suisun Marsh Preservation Agreement.** The SWRCB's D-1485 directed the CVP and SWP to develop a plan to protect Suisun Marsh resources. An agreement was signed in 1987 with the goal to mitigate the effects of the CVP and SWP operations and other upstream diversions on water quality in the marsh.
- **Endangered Fish Species Biological Opinions**. The general decline of several fish species, the delta smelt and spring-run and winter-run salmon in particular, generated much concern resulting in a series of biological opinions from the NOAA Fisheries and the USFWS. These opinions ultimately established requirements to be met by the SWP and CVP to protect these species. These included requirements for Delta inflow and outflow, Delta Cross Channel gate closure, and reduced export pumping. Many of these fish protection requirements were incorporated into the 1995 water quality control plan below. New biological opinions issued in 2008 and 2009 modified some existing requirements such as additional Delta Cross Channel gate closures and slightly different Old & Middle River (OMR) flow targets, and added others, including a Fall X2 (habitat protection outflow) requirement in certain water year types.
- **1995 Water Quality Control Plan and Decision 1641.** The 1995 Water Quality Control Plan for the Sacramento-San Joaquin Delta Estuary (commonly referred to as the Bay-Delta Plan) incorporated several changes recommended by the U.S. Environmental Protection Agency (EPA), NOAA Fisheries, and USFWS to the objectives for salinity and endangered species protection. Decision 1641 (D-1641), established in 1999, implements the objectives in the 1995

Bay-Delta Plan, and imposes flow and water quality objectives to assure protection of beneficial uses in the Delta. In essence, the requirements in D-1641 address standards for fish and wildlife protection, municipal and industrial water quality, agricultural water quality, and Suisun Marsh salinity. The decision added new provisions for X2, export/info ratio, and the Vernalis Adaptive Management Program (VAMP). Meeting the standards was accomplished through changes in the water rights of the CVP, SWP, and others. The SWRCB also granted conditional changes to the point of diversion for the CVP and SWP, in the southern Delta, with D-1641 and approved a petition to change places and purposes of use in the CVP. The 2006 Bay-Delta Plan, which is currently in effect, superseded the 1995 plan.

- **North Delta Water Agency (NDWA).** In 1981, DWR and NDWA executed a contract that ensures that there will be suitable water available in the northern Delta for agriculture and other beneficial uses. Further, a 1998 memorandum of understanding provides that DWR is responsible for any obligation imposed on NDWA to provide water to meet Bay Delta flow objectives so long as the 1981 contract remains in effect.
- **Delta Protection Act and Area of Origin statutes.** See the discussion under the Water Supplies section above.

PLACEHOLDER Table D-2 Laws, Directives, and Orders Affecting CVP and SWP Operations

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Water Quality

In the Delta, there are three applicable water quality control plans that establish water quality objectives for the Delta based on the identified beneficial uses of Delta waters. They are the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (SWRCB 2006), Water Quality Control Plan for the San Francisco Bay Basin (SFBRWQCB 2011), and the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (CVRWQCB 2011). Those beneficial uses include:

- Municipal and domestic supply.
- Industrial service supply.
- Industrial process supply.
- Agricultural supply.
- Groundwater recharge.
- Navigation.
- Water contact recreation.
- Non-contact water recreation.
- Shellfish harvesting.
- Commercial and sport fishing.
- Warm freshwater habitat.
- Cold freshwater habitat.
- Migration of aquatic organisms.
- Spawning, reproduction, and/or early development.
- Estuarine habitat.
- Wildlife habitat.
- Rare, threatened, or endangered species.

Surface Water Quality

Generally, water quality in the Delta is affected by hydrologic conditions. The north part of the Delta, which is dominated by Sacramento River water, generally has better water quality than the south part of the Delta, which is dominated by San Joaquin River water and ocean tides. Land use, dredging, diversions, and point-source and non-point source inputs of pollutants also influence Delta water quality. In addition to water quality challenges from nutrients and salinity, Delta waters do not meet the water quality standards for certain constituents and thus are considered impaired.

Delta water quality is impaired due to:

- Pesticides (chlorpyrifos, diazinon, group A pesticides, DDT, chlordane, dieldrin, diuron).
- Mercury.
- Polychlorinated biphenyls (PCBs).
- Invasive species.
- Localized impairments have been identified for:
    - Pyrethroids in Morrison Creek.
    - Electrical conductivity in the southern portion of the Delta.
    - Low dissolved oxygen in the vicinity of Stockton and the South Delta.
    - Pathogens in the vicinity of Stockton and in Marsh Creek.
    - Selenium in the West Delta (SWRCB 2010).

Pesticides causing impairment of the Delta are human-made chemicals used to control pests, insects, and undesirable vegetation in urban and agricultural landscapes. A fraction of the applied pesticides can enter Delta waterways during rainfall or irrigation events when residual pesticides migrate in stormwater runoff or irrigation return water or migrate with sediment carried in stormwater runoff or irrigation return water and cause unintended toxicity to aquatic life.

High levels of mercury in fish are of concern to people and wildlife that eat Delta fish. Sources of inorganic mercury in the Delta include tributary inflows from upstream watersheds, atmospheric deposition, urban runoff, dredging activities, and municipal and industrial wastewater. Sources of inorganic mercury in the watersheds upstream of the Delta include gold and mercury mine sites, legacy mercury in the stream channel sediments, geothermal springs, atmospheric deposition, urban runoff, and municipal and industrial wastewater (CVRWQCB 2010).

PCBs have been classified as probable human carcinogens and the primary exposure is through consumption of PCBs-contaminated fish. PCBs manufacture and distribution in commerce of materials containing detectable PCBs have been banned, but large quantities of PCBs remain in use. PCBs have been introduced to the environment through land disposal, accidental spills and leaks, incineration of PCBs or other organic material in the presence of chlorine, pesticide applications, surface coatings such as paints and caulks, and wastewater discharge. In the San Francisco Bay, large quantities of PCBs are present in the water column and sediment (SFBRWQCB 2008).

Non-native invasive species in the Delta create a wide range of stresses on native species. They have altered food webs and habitats, compete with native species for resources, and prey upon native species directly. Non-native invasive species have been introduced into the Delta over time via watercraft, fishing gear, live bait intentionally (either legally or illegally) introduced for recreational or other purposes, or released from aquariums into the environment (DFG 2011).

Low dissolved oxygen concentrations may act as a barrier to upstream spawning migration of Chinook salmon and may stress and kill other resident aquatic organisms. The Stockton Deep Water Ship Channel (DWSC) is a portion of the San Joaquin River that has been dredged by the USACE to allow for the navigation of ocean going cargo vessels between San Francisco Bay and the Port of Stockton. Three main factors contribute to the dissolved oxygen impairment of the DWSC:

- Loads of oxygen-demanding substances such as algae from upstream sources that react by numerous chemical, biological, and physical mechanisms to remove dissolved oxygen from the water column in the DWSC.
- DWSC geometry impacts various mechanisms that add or remove dissolved oxygen from the water column, such that net oxygen demand exerted in the DWSC is increased.
- Reduced flow through the DWSC impacts mechanisms that add or remove dissolved oxygen from the water column, such that net oxygen demand in the DWSC is increased (CVRWQCB 2005).

Other dissolved oxygen impairments in the vicinity of Stockton and the South Delta are most likely due to excess loadings of oxygen demanding substances.

Pathogens and fecal coliforms are a human health concern for drinking water and recreational uses. These bacteria may be introduced to a water body from many sources including faulty sewer and septic systems, urban runoff, animal wastes, and land use runoff from both developed and undeveloped systems (EPA 2001).

Selenium has been identified as a potential bioaccumulation concern in white sturgeon, and probably green sturgeon, in San Francisco Bay and the West Delta. Selenium mainly originates from natural sources although these sources are often concentrated and redistributed by anthropogenic activities such as agricultural management practices. Fossil fuels, such as coal and crude oil, are also naturally enriched with selenium. Thus, refining and cracking of crude oil, combustion of fossil fuels and solid wastes, microbial activity, and industrial processes also release selenium to the atmosphere and surface waters. The main sources of selenium to the North San Francisco Bay and the West Delta are industrial and municipal discharges including petroleum refineries, urban and non-urban runoff, erosion and sediment transport within the North San Francisco Bay, flow from Central Valley watersheds through the Delta, and atmospheric deposition (SFBRWQCB 2011).

Nutrients

Plant nutrients of concern in water are primarily nitrogen and phosphorus compounds including ammonia, ammonium, nitrite, nitrate, and phosphate. Excessive amounts (over fertilization) or altered proportions of these nutrients in streams, rivers, lakes, estuaries, or the coastal ocean can have detrimental effects on ecosystems. Die-offs of algae that deplete oxygen and cause fish kills are a well-known example, but even less obvious effects of nutrients can have important impacts on aquatic ecosystems. Changes in the types of algae that form the base of the aquatic food web, including growth of toxic algae, have been linked to excessive amounts or altered ratios of plant nutrients. Ratios of nutrients in Delta waters are thought to be a primary driver in the composition of aquatic food webs in the Bay Delta (Glibert et al. 2011). The effect of ammonium on food webs in the Delta remains an open question, and much active research and healthy scientific debate continue.

San Francisco Bay has long been recognized as a nutrient enriched estuary. Nonetheless, dissolved oxygen concentrations found in the bay's subtidal habitats are much higher and phytoplankton biomass and productivity are substantially lower than would be expected in an estuary with such high nutrient enrichment. This implies that eutrophication is controlled by processes other than straightforward nutrient limitation of primary production. The published literature suggests that phytoplankton growth and accumulation are largely controlled by a combination of factors, including strong tidal mixing, light limitation due to high turbidity, and grazing pressure by clams (Cloern and Jassby 2012).

There is a growing body of evidence that suggests the historic resilience of San Francisco Bay to the harmful effects of nutrient enrichment is weakening. Since the late 1990s, regions of the bay have experienced significant increases in phytoplankton biomass (30 – 105percent from Suisun to South Bay) and declines in dissolved oxygen concentrations (2 percent and 4 percent in Suisun Bay and South Bay, respectively (Cloern, unpublished data). In addition, an unprecedented autumn phytoplankton bloom in October 1999, and increased frequency of cyanobacteria and dinoflagellate (the 2004 red tide event) blooms occurring in the North Bay, further signal changes in the estuary. The Delta has experienced blooms of harmful algal species (e.g., *microcystis aeruginosa*) that produce toxins that can impact human health and wildlife.

Salinity

Salinity enters the Delta from the tides and from return flows from agricultural lands, principally in the San Joaquin Valley. Prior to the construction of today's water supply and flood control facilities, salinity levels were lower in the winter and spring and higher in the summer and fall. Delta salinity levels are currently mandated by water quality control regulations. Some evidence indicates the current (less variable) salinity regime may favor invasive species to the detriment of native species. Small amounts of salt in urban supplies can negatively affect consumer perception and acceptance of tap water. Slightly higher salinities decrease crop yields. Increasing salinity in both agricultural and urban water decreases how the water can be used and, at too high a level, can make the water unusable. While the ecosystem may benefit from more variability in the salinity, the water diversions for agricultural and urban uses rely upon a more constant low level salinity.

Central Valley Salinity Alternatives for Long-Term Sustainability

In the Central Valley, which contains almost all of the Delta, the Central Valley Water Quality Control Board (CVWQCB) and the SWQCB are working with a stakeholder coalition and are developing a comprehensive salinity and nutrient management plan for the Central Valley. The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is a strategic initiative to address problems with salinity and nitrates in the surface waters and groundwaters of the Central Valley. The long-term plan developed under CV-SALTS will identify and implement future management measures aimed at the regulation of major sources of salt. As this issue impacts all users (stakeholders) of water within the Delta, it is important that all stakeholders participate in CV-SALTS to be part of the development and have input on the implementation of salt and nitrate management within the Delta Area. In the Central Valley, the only acceptable process to develop the salt and nutrient management plans that are required under State policy (SWRCB 2009) is through CV-SALTS.

Drinking Water Quality

The Delta provides drinking water to more than 25 million people in the Southern California, the Central Coast, and the San Francisco Bay regions, and several million people obtain their water supply from the tributaries of the Delta. The tributaries of the Sacramento and San Joaquin rivers that originate in the Cascade and Sierra Nevada mountains generally have high quality water. However, as the tributaries flow into lower elevations, they are affected by urban, industrial, and agricultural land uses, natural processes, and a highly managed water supply system.

In general, drinking water systems in the region deliver water to their customers that meet federal and State drinking water standards. Recently the Regional Water Quality Control Boards (RWQCB) completed a draft statewide assessment of community water systems that rely on contaminated groundwater. This draft report identified 21 community drinking water systems in the region that rely on at least one contaminated groundwater well as a source of supply (see Table D-3). Arsenic is the most prevalent groundwater contaminant affecting community drinking water wells in the region (see Table D-4). The majority of the affected systems are small water systems, which often need financial assistance to construct a water treatment plant or alternate solution to meet drinking water standards.

PLACEHOLDER Table D-3 Summary of Community Drinking Water Systems in the Sacramento-San Joaquin Delta Region that Rely on One or More Contaminated Groundwater Wells that Exceed a Primary Drinking Water Standard

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

PLACEHOLDER Table D-4 Summary of Contaminants Affecting Community Drinking Water Systems in the Sacramento-San Joaquin Delta Region

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

Groundwater Quality

Groundwater quality in the Delta Area is generally good with the following contaminants:

- Arsenic (SWRCB 2012, USGS 2010 and USGS 2011)
- Localized contamination has been identified:
  - Organic compounds (SWRCB 2012).
  - Nitrates (SWRCB 2012).
- Hexavalent Chromium (SWRCB 2011b).

The primary source of arsenic in groundwater in the Delta is minerals eroded from the volcanic and granitic rocks of the Sierra Nevada. Geochemical conditions in and near the Delta Area are conducive to arsenic dissolution.

Chromium is a metal found in natural deposits of ores containing other elements, mostly as chrome-iron ore. It is also widely present in soil and plants. Recent sampling of drinking water throughout California suggests that hexavalent chromium may occur naturally in groundwater at many locations. Chromium may also enter the environment from human uses. Chromium is used in metal allows such as stainless steel protective coatings on metal, magnetic tapes, and pigments for paints, cement, paper, rubber, composition floor covering, etc. Elevated levels (above the detection limit of 1 µg/l) of hexavalent chromium have been detected in many active and standby public supply wells along the west or valley floor portion of the Central Valley (SWRCB 2011b).

Suisun Marsh Water Quality

The Suisun Marsh water quality is impaired due to:

- Low dissolved oxygen (DO)/organic enrichment
- Mercury
- Nutrients

Acute drops in dissolved oxygen concentrations in Suisun Marsh have been observed regularly in the fall. Some of these low DO events have caused documented fish kills. The recurring DO problems are linked to seasonal operations of ponds and wetlands managed for waterfowl hunting. For most of the year, duck club ponds are drained and occasionally flooded to promote the growth of plants that are the favored food of waterfowl. Vegetation manipulation, in conjunction with flooding of these areas for hunting, periodically results in discharges of anoxic black water from the diked marshes. The discharges, laden with decaying plant matter, can cause severe dissolved oxygen depletion.

The duck pond discharges are also rich in nutrients and organic carbon that further stimulate microbial activity and establish conditions that promote methylation of mercury. Methylmercury, one of the most toxic forms of mercury, enters the aquatic food web and can accumulate to levels of concern in fish and wildlife at the top of the aquatic food chain. The concerns related to mercury apply broadly in the marsh other than associated with duck pond discharges in that concentrations of methylmercury in fish found in Suisun Marsh and the Delta exceed levels that may be harmful to human health. Also, increased methylmercury production is a significant concern for planned tidal wetland restoration projects. Suisun Marsh is also listed for nutrient impairment and the conditions in the larger slough channels within the marsh that connect to Suisun Bay currently reflect similar conditions of low primary productivity observed in Suisun Bay. There is little available information regarding other potential impacts of nutrients in the marsh, such as nuisance algal blooms.

San Francisco Bay RWQCB is working on a multi-pollutant total maximum daily load (TMDL) to address these water quality impairments in Suisun Marsh.

Flood Management

California’s water resource development has resulted in a complex, fragmented, and intertwined physical and governmental infrastructure. Although primary responsibility might be assigned to a specific local entity, aggregate responsibilities for flood management are spread among more than 200 agencies in the Sacramento-San Joaquin Delta area with many different governance structures. A list of these agencies can be found in *California’s Flood Future Report*. These governmental entities are collectively responsible for operating and maintaining water management facilities, as well as maintaining and upgrading levees that protect lands and assets in the Delta Area. Agency roles and responsibilities can be limited by how the agency was formed, which might include enabling legislation, a charter, a memorandum of understanding with other agencies, or facility ownership.

Central Valley Flood Protection Board

The Central Valley Flood Protection Board (CVFPB), created in 1911 as the Reclamation Board, is the State agency charged with overseeing flood management in California’s Central Valley. The CVFPB works with the USACE, DWR, other federal and State agencies, and local maintaining agencies in approving funding and projects to continuously improve and expand the Central Valley flood management system. Voter-approved Propositions 84 and 1E of 2006 provided the funding to begin, and in many cases, complete larger, more significant flood system improvement projects.

Central Valley Flood Protection Plan

Senate Bill (SB) 5 (2008), Flood Management, requires the DWR and the CVFPB to prepare and adopt a Central Valley Flood Protection Plan (CVFPP) by 2012. The CVFPP was adopted in June 2012. SB 5 also requires cities and counties in the Sacramento-San Joaquin Valley to amend general plans, within 24 months of June 2012, to contain feasible implementation measures designed to carry out the goals, policies, and objectives to reduce the risk of flood damage, based on data and analysis contained in the CVFPP. Each county shall develop flood emergency plans in collaboration with cities within its jurisdiction. Within 36 months of June 2012, cities and counties of the Sacramento-San Joaquin Valley are required to amend zoning ordinances to be consistent with the amended general plans. By 2015, these cities or counties will be prohibited from entering into a development agreement, approving any permit, entitlement, or subdivision map unless an urban level of flood protection is provided in urban and urbanizing areas or until the FEMA (Federal Emergency Management Agency) standard of flood protection is provided in non-urbanized areas. The urban level of flood protection is defined as protection against flooding that has a 1-in-200 chance of occurring in any given year.

Delta Levees Subventions Program

The Delta Levees Subventions Program was authorized in 1973 and reimburses local levee maintaining agencies in the legal Delta for a portion of their levee maintenance costs. Following the historic floods of 1986, the Subventions Program was expanded, and a second program, Special Flood Control Projects (aka Special Projects Program), was added in 1988 to provide State support for major levee repair and reconstruction work in the eight western Delta Islands that are considered critical to maintaining water supply. The 1988 changes (SB 34) required that expenditures result in “no net long-term loss of habitat,” a new mandate that was expanded in 1996 (AB360) to require that program expenditures result in “net habitat improvement” in addition to “no net loss.” While subsequent amendments to the program expanded the Special Projects Program to the entire Delta rather than only the western islands, the focus of both Subventions and Special Projects has been on non-project levees, though the programs can support work on project levees in the Delta’s Primary Zone.

Other Flood Related Laws and Plans

A number of laws regarding flood risk and land use planning were enacted in 2007. These laws establish a comprehensive approach to improving flood management by addressing system deficiencies, improving flood risk information, and encouraging links between land use planning and flood management. Many of the requirements set down by these laws are only applicable within the Central Valley. A list of the legislation is provided below and a summary of each is available in the *California’s Flood Future Report.*

- Senate Bill (SB) 5 (2008).
- Flood Management Assembly Bill (AB) 156 (2007).
- Flood AB 70 (2007) Flood Liability.
- AB 162 (2007) General Plans The Sacramento-San Joaquin Delta Reform Act of 2009.

California Water Code (CWC) Sections 85020(g), 85225, and 85305-85309 have special significance to flood management activities in the Delta and are summarized in *California’s Flood Future Report.*

A number of proposed regulatory policies in the Delta Plan require covered actions to file for consistency with the Delta Plan policies, prioritize State investments in Delta levees and risk reduction, require flood protection for residential development in rural areas, protect floodways and floodplains, as well as expand floodplains and riparian habitats in levee projects.

Risk Characterization

Common flood types in the Delta include stormwater, slow-rise, and coastal flooding. Other possible flood types include tsunami and engineered structure failure. Throughout the Delta, levees were originally constructed from material dredged from adjacent channels, which have been improved in various places since then to hold back river and tidal waters. These levees are subject to damage from rodents, piping, and possibly from foundation movement. These effects could lead to sudden failure at any time since many Delta levees hold back water throughout the year. Most of the area's precipitation falls from December through March. Monthly rainfall can come within a single 24-hour period during winter storms. Winter storms bring both high inflows and windy conditions. In combination with annual and daily high tides, this could cause waves to wash over and damage Delta levees, potentially leading to failure. When an island floods, the fetch (the distance along open water or land over which the wind blows or the distance waves can traverse unobstructed) is increased to the full width of the island. The waves could cause extensive damage to unprotected interior levee slopes.

Historic Floods

Flood Descriptions

Major floods occur regularly in the Sacramento-San Joaquin Delta area. Some urban and small-stream flooding occurs in every large storm. Floods during winter storms that cause high-water surface elevations and have strong winds have been a common cause of levee failures in the Delta. For example, the flows of the Sacramento River at Rio Vista during winter and early spring are often 30 times the typical late-summer flows. High water in the Delta can overtop levees, as well as increase the hydrostatic pressure on levees and their foundations, causing instability and increasing the risk of failure due to through-levee and/or under-levee seepage.

Delta levee failures have caused 165 inundations of islands and tracts since 1900 (URS 2008). Tides and water-level surges due to low atmospheric pressure will contribute to high-water levels at times, which may or may not coincide with periods of high Delta inflow caused by floods. Some inflow floods will have high contributions from the Mokelumne, Cosumnes, San Joaquin, or other smaller tributaries and other contributions will be primarily from the Sacramento River. In addition, isolated sunny-day levee failures (like that on the Upper Jones Tract in June 2004) will occur. These failures could be caused by burrowing activities that compromised the integrity of the levees.

Floods have been recorded in Central Valley for more than 175 years. The most notable flood in the 19^{th} century was the Great Flood of 1861-1862. Central Valley floods of 1907 and 1909 revised flood management plans of the time and led to development of the San Joaquin River flood management system. Additionally, the flood of 1986-1987 resulted in legislation to improve the Delta Levees Program.

Flood Exposure

Flood exposure in the Sacramento-San Joaquin Delta area is widespread throughout the whole region. The Legislature recognized that the Delta is a critically important natural resource for California and the nation. Flood exposure identifies who and what is impacted by flooding. Flood exposure provides a limited representation of detailed flood risk. Two levels of flood events are commonly used to characterize flooding:

- 100-Year Flood is a shorthand expression for a flood that has a 1-in-100 probability of occurring in any given year. This can also be expressed as the 1 percent annual chance of, or 1 percent annual chance flood.
- 500-Year Flood has a 1-in-500 (or 0.2 percent) probability of occurring in any given year.

In the Sacramento-San Joaquin Delta area, nearly half the resident population and $18 billion in assets are exposed to the 500-year flood event. Table D-5 provides a snapshot of people, structures, crops, and infrastructure, and sensitive species exposed to flooding in the area. Figures D-9 and D-10 show the exposure to flood hazard in the Sacramento-San Joaquin Delta area. More than 100 threatened, endangered, listed, or rare plant and animal species exposed to flood hazards are distributed throughout the Sacramento-San Joaquin Delta area

PLACEHOLDER Table D-5 Sacramento-San Joaquin Delta Area Exposures within the 100-Year and 500-Year Floodplains

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PLACEHOLDER Figure D-9 Statewide Flood Hazard Exposure Summary for the Sacramento-San Joaquin Delta Region 100-year Floodplain

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PLACEHOLDER Figure D-10 Statewide Flood Hazard Exposure Summary for the Sacramento-San Joaquin Delta Region 500-year Floodplain

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Levee Performance and Risk Studies

Different levees in the Delta were built to different standards. There are 380 miles of project levees that are maintained by local reclamation districts with oversight and inspection from the State in conformance with federal levee policies. These levees were built to standards that generally exceed the PL 84-99 federal standard. Urban levees, 63 miles of which are non-project levees, must meet the 200-year flood protection standards, as defined in the Central Valley Flood Protection Act of 2008, by 2025. DWR is developing criteria for these urban levees that will generally be more stringent than the current criteria for project levees. The remaining 537 miles are non-urban, non-project levees. The Sacramento District of the USACE and DWR set geometric standards for the crown height and width and for slopes of agricultural levees (non-project levees). The State Hazard Mitigation Plan (HMP) standard was viewed as an intermediate standard with the long-term goal of upgrading to the higher federal standard of PL 84-99. While the original goal was to use September 10, 1991, as a deadline for qualifying levees to be eligible for federal disaster assistance, actual practice allowed for federal aid where sufficient progress was being made in meeting the criteria. In 2006, FEMA made it a rigid requirement for levees to meet the HMP criteria at the time of a disaster to qualify for federal aid. In 2010, FEMA and the California Emergency

Management Agency (Cal EMA) modified their memorandum of understanding (MOU) (FEMA 2010) to clarify the criteria and again allow federal aid for levees not meeting the HMP standard if certain criteria including demonstrated progress for levee upgrades were met. In December 2012, FEMA terminated MOU, stating the previous MOU was vague and failed to address both current levee standards and FEMA's Public Assistance Policy adequately. As of 2013, FEMA and Cal EMA are discussing how to resolve the issue. Without the MOU, the eligibility of Delta levees for FEMA recovery and flood-fighting assistance remains unclear. In the meantime, it appears that FEMA will use its national policy (FEMA 2011) that covers FEMA assistance, especially when levees don't meet PL 84-99 standards.

Most non-project Delta levees satisfy HMP standards and about 47 percent met the PL 84-99 as of February 2007 based on data from DWR (Gilbert Cosio 2013, personal communication, 15 April). Today that number is most likely higher due to additional work completed with Proposition IE funds.

Delta levee improvements performed since the late 1970s have gradually strengthened many miles of levees, making them less vulnerable. The Sacramento and San Joaquin River Flood Control projects that were completed in the 1960s strengthened project levees. Upstream dams constructed in the 1950s and 1960s attenuated moderate flood flows. When funds currently slated for levees have been expended, more than $698 million will have been invested in improvements to Delta levees since 1973 (Delta Protection Commission 2012).

Evaluations of levees for individual Delta islands and tracts are used to plan local levee repairs and upgrades periodically. In addition, several Delta-wide studies of levees have considered the vulnerability of Delta levees to potential failure. Each of these studies highlighted the relatively high chance of continued Delta levee failures. The reclamation districts have been funded individually by DWR to produce 5-year plans for upgrading their levees.

31 local flood management projects or planned improvements are identified in the Sacramento-San Joaquin Delta area. These projects represent a subset of the work that needs to be completed in the Delta. These projects and improvements are summarized in the DWR State Flood Management Plan (SFMP) *California's Flood Future: Recommendations for Managing the State's Flood Risk Report* (*California's Flood Future Report*). A list of the local flood management projects can be found in *California's Flood Future Report*.

The local projects identified during the SFMP information gathering have costs totaling approximately $1.2 billion. Eight of the local planned projects use an integrated water management (IWM) project approach with a flood management component. Examples of local IWM projects include the Dutch Slough Tidal Marsh Restoration, the Budlisilich Fish Passage Improvements, and the Lower San Joaquin River Flood Bypass.

Resource Planning in the Delta

Delta Plan

The primary responsibility of the DSC is to develop, adopt, and implement a legally enforceable, comprehensive, long-term management plan for the Sacramento-San Joaquin Delta and the Suisun Marsh called the Delta Plan. This will achieve the coequal goals of providing a more reliable water supply for

California and protecting, restoring, and enhancing the Delta ecosystem in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. The Delta Plan was adopted by the DSC on May 16, 2013.

The Delta Plan builds on work by DWR, DFW, and Wildlife, and the SWRCB. Collectively, its required policies and numerous recommendations:

- Reduce reliance on water from the Delta by requiring those who take water from the Delta, transfer water through the Delta, or use water in the Delta to describe and certify that they are using all feasible options to use water efficiently and to develop additional local and regional water supplies.
- Identify ways to improve statewide water supply reliability throughout California by calling for State investments in improved local and regional supplies and water use efficiency. The plan also calls for improved Delta conveyance and expansion of groundwater and surface storage.
- Protect, restore, and enhance the Delta ecosystem by designating six high priority locations in the Delta and Suisun Marsh to recover endangered species, rebuild salmon runs, and enhance habitat for wildlife. The plan also prioritizes actions to reduce pollution, ensure improved water quality and limit invasive species, while moving to establish a more natural pattern of water flows in the Delta.
- Protect the uniqueness of the Delta by preserving rural lands for agriculture and habitat use, and require that new residential, commercial, or industrial development is located in areas currently designated for urban use.
- Reduce risks to people, property, and State interests in the Delta by prohibiting encroachment on floodways and floodplains, requiring a minimum level of flood protection for new residential development of five or more parcels, and committing to develop priorities for State investment in Delta flood protection by 2015.
- Integrate governmental actions and the best available science through regulatory policies and non-binding recommendations.
- Call for swift and successful completion of the Bay Delta Conservation Plan, which seeks to modernize the existing water conveyance system, and improve the health of the estuary. If the BDCP meets the requirements of law it will be incorporated into the Delta Plan.

The Delta Plan is a long-term management plan and will be updated every five years. It includes 73 non-regulatory recommendations to be considered by other agencies, the Legislature, or the governor. The Delta Plan presents a view of the diversity of the water supply system and its components, including demands for water and how water is currently used, together with the need for an improved Delta ecosystem. The planning timeframe is 2100, using monitoring and adjusting of decisions (adaptive management),” informed by the best available science.

Some elements of the Delta Plan will have regulatory effects. Any plan, project, or program that meets certain criteria will be subject to regulations included in the Delta Plan, and the project proponents must certify consistency with the Delta Plan. There are 14 regulations in the Delta Plan that will take effect on September 1, 2013. The policies are as follows:

- GP1: Detailed Findings to Establish Consistency with the Delta Plan.
- WR P1: Reduce Reliance on the Delta through Improved Regional Water Self Reliance.
- WR P2: Transparency in Water Contracting.
- ER P1: Delta Flow Objectives.

- ER P2: Restore Habitats at Appropriate Elevations.
- ER P3: Protect Opportunities to Restore Habitat.
- ER P4: Expand Floodplains and Riparian Habitats in Levee Projects.
- ER P5: Avoid Introductions of and Habitat Improvements for Invasive Non-native Species.
- DP P1: Locate New Urban Development Wisely.
- DP P2: Respect Local Land Use When Siting Water or Flood Facilities or Restoring Habitats.
- RR P1: Prioritization of State Investments in Delta Levees and Risk Reduction.
- RR P2: Require Flood Protection for Residential Development in Rural Areas.
- RR P3: Protect Floodways.
- RR P4: Floodplain Protection.

Bay Delta Conservation Plan

The Bay Delta Conservation Plan (BDCP) is a HCP/NCCP intended to make significant contributions to the recovery of priority fish and wildlife species while securing reliable water supplies from the Delta for human use. The BDCP is planned to be implemented over a 50-year timeframe according to an adaptive management program. The parties seeking permits pursuant to the BDCP include DWR, U.S. Bureau of Reclamation, Metropolitan Water District of Southern California, the Kern County Water Agency, the Santa Clara Valley Water District, Zone 7 Water Agency, Westlands Water District, and the State and Federal Water Contractors Agency (BDCP 2013). The goal of these parties is to formulate a plan that could ultimately be approved by the USFWS and the NMFS as an HCP under the provisions of Endangered Species Act section 10(a)(1)(B) and as an NCCP by DWF under Fish and Game Code Sections 2800 et seq. and/or the California Endangered Species Act Sections 2050 et seq. If the BDCP is approved and permitted and meets specific requirements in CWC Section 85320(e), it would become part of the Delta Plan. The DSC has a potential appellate role regarding the inclusion of BDCP in the Delta Plan.

The BDCP contains conservation measures to protect, restore, enhance, and manage physical habitat to expand the extent and quality of intertidal, floodplain, and other habitats across defined conservation zones. It also contains measures to reduce the effect of various stressors on covered species, such as toxic contaminants, non-native predators, illegal harvest, and non-project water diversions. In addition to meeting the conservation needs of priority species, the BCDP aims to contribute to improving exported water supply reliability by modifying Delta conveyance facilities to create a more natural flow pattern in the Delta to benefit fish species. This is intended to allow for water exports when hydrologic conditions result in the availability of sufficient water, to be consistent with the requirements of State and federal law and the terms and conditions of SWP and CVP water delivery contracts and other existing applicable agreements.

The BDCP process is considering a range of options for conveying water through or around the Delta, however, the preferred alternative is the dual conveyance system:

- Through-Delta Conveyance: Continue to divert water in southern Delta at existing or modified intakes/diversions for SWP and CVP operation.
- Isolated Conveyance: Divert water from the Sacramento River at new North Delta intakes/diversions and convey the water to the existing SWP and CVP pumping plants through a pipeline/tunnel.
- Dual Conveyance: Combine through-Delta conveyance and isolated conveyance to allow operation flexibility.

While the BDCP intends to provide ecological benefits to the Delta and statewide benefits of a more reliable water supply, there are impacts to the Delta community from the BDCP. The Administrative Draft EIR/EIS of the BDCP identified the following negative impacts for the Delta (ICF International 2013):

- Permanent loss of substantial amounts of important farmland.
- Long-term reduction in recreation opportunities.
- Permanent regional economic effects in the Delta.
- Increases in long-term average bromide concentrations at Barker Slough, Staten Island, and Emmaton on the Sacramento River.
- Substantially increased chloride concentrations in the Delta such that the frequency of exceeding the 150 mg/L Bay-Delta Water Quality Control Plan objective would approximately double.
- Increases in long-term average electrical conductivity (EC) levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses.

The BDCP process is ongoing. As of the writing of this report, the BDCP Draft Administrative Chapters and Administrative Draft of the EIR/EIS are available. The Public Draft EIR/EIS is scheduled for release by October 1, 2013.

Bay-Delta Water Quality Control Plan Update

The SWRCB's Bay-Delta Water Quality Control Plan (aka Bay-Delta Plan) identifies beneficial uses of the Bay Delta, water quality objectives for the reasonable protection of those beneficial uses, and a program of implementation for achieving the water quality objectives including control of salinity caused by saltwater intrusion, municipal discharges, and agricultural drainage, and water projects operations.

The SWRCB is in the process of a phased review and update of the 2006 Bay-Delta Plan. This will include review of potential modifications to current objectives included in the 2006 Bay-Delta Plan, the potential establishment of new objectives, and modifications to the program of implementation for those objectives. It will also include potential changes to the monitoring and special studies program included in the 2006 Bay-Delta Plan. The water quality control planning process will not include amendments to water rights and other measures to implement a revised Bay-Delta Plan. A separate Environmental Impact Report will be prepared for these actions In addition, a separate Substitute Environmental Document is being prepared to address updates to the water quality objectives for the protection of southern Delta agricultural beneficial uses, San Joaquin River flow objectives for the protection of fish and wildlife beneficial uses, and the program of implementation for those objectives.

Triennial Review of the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins

To meet requirements of the federal Clean Water Act section 303(c) and CWC Section 13240, the Central Valley Regional Water Quality Control Board (CVRWQB) reviews the water quality standards contained in the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins every three years. The basin plan is the foundation for the RWQCB's water quality regulatory programs. It designates beneficial uses for both surface and groundwater bodies in the Central Valley, establishes water quality objectives to protect those beneficial uses, contains implementation plans that describe the actions necessary to achieve water quality objectives, and describes the surveillance and monitoring activities needed to determine regulatory compliance and assess the health of the basins' water resources.

Strategic Work Plan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary

The CVWQCB, San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), and SWRCB adopted a Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Strategic Workplan) in July 2008 (SWRCB 2008). The Strategic Workplan was written in response to two SWRCB resolutions describing the actions they will complete to protect the beneficial uses of water in the Bay Delta estuary. The work plan activities are divided into nine broad categories:

- Water quality and contaminant control.
- Comprehensive Delta monitoring program.
- Southern Delta salinity and San Joaquin River flow objectives.
- Suisun Marsh objectives.
- Comprehensive review of the Bay-Delta Plan, water tights, and other requirements to protect fish and wildlife beneficial uses and the public trust.
- Methods of diversion of the SWP and CVP.
- Water rights compliance, enforcement, and other activities to ensure adequate flows to meet water quality objectives.
- Water use efficiency for urban and agricultural water users.
- Other actions.

Ecosystem Restoration Program

The Ecosystem Restoration Program (ERP) is a multi-agency effort aimed at improving and increasing aquatic and terrestrial habitats and ecological function in the Delta and its tributaries. Principal participants overseeing ERP are the DFW, the USFWS, and the NMFS, collectively known as the ERP Implementing Agencies. The program's primary role is to provide funding and management for projects throughout the Sacramento-San Joaquin Delta, Sacramento Valley, and San Joaquin Valley. Current work in the Delta includes, but is not limited to, habitat restoration (including riparian, upland, floodplain, shallow water and marsh habitat), fish screens and fish passage, ecosystem water quality, non-native invasive species, historical ecology, and food web productivity. Various documents and reports related to these issues are at http://www.dfg.ca.gov/ERP/reports_docs.asp.

The ERP is currently developing a Conservation Strategy to guide stage 2 implementation. The conservation strategy describes the ecosystem restoration goals and conservation priorities that will be utilized by the ERP Implementing Agencies. Portions of the Conservation Strategy are being incorporated into the Delta Plan, including a description of and rationale for habitat types targeted for restoration, suggested actions for management of non-native invasive species, and an elevation map to help guide habitat restoration priorities in the Delta. Additionally, ERP staff coordinated with the Delta Science Program to ensure that the ERP adaptive management framework, as revised for the ERP Conservation Strategy, aligns with the adaptive management framework in the Delta Plan.

The ERP coordinates with other programs and activities within the Delta including Delta Conservancy, Central Valley Project Improvement Act/Anadromous Fish Restoration Program, Fish Restoration Program Agreement, FloodSAFE California Initiative, BDCP, Fish Passage Improvement Program, Delta

Vision Foundation, State Wildlife Action Plan, California Water Quality Monitoring Council, and the CVRWQCB.

Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta

The California Department of Fish and Wildlife is required by CWC Section 85084.5 to develop quantifiable biological objectives and flow criteria for species of concern dependent on the Delta. The report, *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta,*" contains the recommendations, rationale, and justification for biological objectives to protect aquatic and terrestrial species of concern that are dependent on the Delta, and) flow criteria that would benefit aquatic species of concern. This was submitted to the SWRCB in November 2010. The report is at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=25987.

Central Valley Flood Protection Plan

The Central Valley Flood Protection Act of 2008 directed DWR to prepare the Central Valley Flood Protection Plan (CVFPP). The CVFPP is a flood management planning effort that addresses flood risks and ecosystem restoration opportunities in an integrated manner while concurrently improving ecosystem functions, operations and maintenance practices, and institutional support for flood management. It specifically proposes a systemwide approach to flood management for the areas currently protected by facilities of the State Plan of Flood Control (SPFC). Under this approach, California will prioritize investments in flood risk reduction projects and programs that incorporate ecosystem restoration and multi-benefit projects. The CVFPP was adopted by the Central Valley Flood Control Board on June 29, 2012. It is expected that the CVFPP will be updated every 5 years thereafter.

The CVFPP proposes a systemwide approach to address the following issues:

- Physical improvements in the Sacramento and San Joaquin River basins.
- Urban flood protection.
- Small community flood protection.
- Rural/Agricultural area flood protection.
- System improvements.
- Non-SPFC levees.
- Ecosystem restoration opportunities.
- Climate change considerations.

The geographic scope of the CVFPP includes only the portions of the Delta covered by the SPFC. Approximately two-thirds of Delta levees are not addressed in the CVFPP.

Delta Risk Management Strategy

The Delta Risk Management Strategy (DRMS) is expected to lead to development of strategies to manage the risk of Delta Area levee failure and to improve management of State funding supporting Delta Area levee maintenance and improvement. DWR directed the study, which was sponsored by DWR, DFW, and USACE, guided by 20 subject experts from federal, State, local, and private organizations and performed by about 30 consultants in appropriate fields. The DRMS is in two phases. Phase 1, completed in 2007, identified three risks to Delta area levees (earthquake, high water, and levee and foundation deterioration) and evaluated the consequences in terms of cost, water quality effects, ecosystem effects, and public health and safety. Phase 1 concluded that the annual probability of an island being flooded is less than one percent to more than seven percent, depending on the location. Phase 2 evaluated long-term risk-reduction options for Delta Area levees and describes a discrete set of actions that can be taken to reduce the risks and consequences of levee failure. The final Phase 2 report was released in June 2011.

Integrated Regional Water Management Plans

The Integrated Regional Water Management (IRWM) Planning Act, signed by the governor as part of SB1 in 2008 (CWC Section 10530 et seq.), provides a general definition of an IRWM plan as well as guidance to DWR as to what IRWM program guidelines must contain. All IRWM plans must discuss if they contribute to the attainment of one or more of the objectives of the former CALFED Bay-Delta Program. The regional acceptance process is a component of the IRWM Program Guidelines and is used to evaluate and accept an IRWM region into the IRWM grant program. Acceptance and approval is required before any region can submit an application for IRWM grant funds. Approval has been awarded to the six IRWM regions that touch on the Delta: American River Basin, East Contra Costa County, Eastern San Joaquin, San Francisco Bay Area, Westside – San Joaquin, and Westside – Yolo/Solano/Napa/Lake/Colusa (see Figure D -11).

PLACEHOLDER Figure D-11 Regional Acceptance Process IRWM Regions, Sacramento-San Joaquin Delta

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

The Delta region is engaged in IRWM planning through multiple planning regions that empower stakeholders to develop integrated solutions and diversified water management portfolios collaboratively to meet regional water management challenges. The IRWM efforts serve a vital role, in combination with local and statewide planning, to provide for sustainable water use, water quality, and environmental functions.

Integrated water management principals are being applied more frequently in flood management planning. An example of an IWM approach in the Sacramento-San Joaquin Delta area is the Lower San Joaquin River Flood Bypass project, which will increase flood conveyance capacity through a constrained reach of the San Joaquin River floodway by acquiring easements and fee title to expand the Paradise Cut Bypass. The project will also provide floodplain and riparian habitat for sensitive species including riparian brush rabbit, giant garter snake, Sacramento spittail, and juvenile Chinook salmon. The project would reduce flood stage in mainstem San Joaquin River between Vernalis and Stockton and reduce the likelihood of levee failure on the San Joaquin River in the Lathrop, Manteca, and Stockton areas.

The Delta region includes part of six IRWM plans. However, there are no IRWM plans written specifically for the Delta region. Some, like the American River Basin Plan, do not mention the Delta by name, but acknowledge that water supply goals and objectives are consistent with the larger statewide goals and objectives outlined by the CALFED Program. The Westside – Yolo/Solano/Napa/Lake Colusa IRWM Plan will list several specific actions for areas in the Delta. Actions include foundational efforts such as monitoring water quality or subsidence, mercury remediation in the Cache Creek system and Yolo Bypass, Clarksburg levee improvement, and Sutter Slough erosion control.

Three other Delta-related issues most common in these IRWM plans are levee system improvement, new or enlarged surface storage, and upstream ecosystem restoration. Land use, and its accompanying water use, is another aspect explored in the IRWM plans. In many cases, the IRWM plans consider land use and changes in water use as potentially affecting both quality and flow to the Delta.

The following IRWM Plan updates are currently underway and are expected to be completed at the date shown in Table D-6.

PLACEHOLDER Table D-6 Expected Completion for IRWM Plans

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

Some regional projects pertaining to the Delta region are highlighted here.

[Regional project information is still being developed.]

Environmental Stewardship

Climate Change Adaptation

Climate change has the potential to impact the region, which the state depends upon for its economic and environmental benefits. These changes will increase the vulnerability of natural and built systems in the region. Impacts to natural systems will challenge aquatic and terrestrial species with diminished water quantity and quality, and shifting ecoregions. Built systems will be impacted by changing hydrology and runoff timing, loss of natural snowpack storage, which will makes the region more dependent on surface storage in reservoirs and groundwater sources. Increased future water demand for both natural and built systems may be particularly challenging with less natural storage and less overall supply.

Water managers and local agencies must work together to determine the appropriate planning approach for their operations and communities. While climate change adds another layer of uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (EPA and DWR 2011). However, stationarity (the idea that natural systems fluctuate within an unchanging environment of variability) can no longer be assumed, so new approaches will likely be required (Milly et *al. 2008).*

Integrated regional water management (IRWM) planning is a framework that allows water managers to address climate change on a smaller, more regional scale. Climate change is now a required component of all IRWM plans (DWR 2010). IRWM regions must identify and prioritize their specific vulnerabilities, and identify adaptation strategies that are most appropriate. Planning and adaptation strategies that address the vulnerabilities should be proactive and flexible, starting with proven strategies that will benefit the region today, and adding new strategies that will be resilient to the uncertainty of climate change. Other planning efforts in the region that are addressing the potential impacts of climate change include the Delta Plan, the Bay Delta Conservation Plan, the Central Valley Flood Protection Plan, and the Ecosystem Restoration Plan.

However, local agencies, as well as federal and State agencies, face the challenge of interpreting climate change data and determining which methods and approaches are appropriate for their planning needs. The *Climate Change Handbook for Regional Water Planning* (EPA and DWR 2011) provides an analytical framework for incorporating climate change impacts into a regional and watershed planning process and considers adaptation to climate change. This handbook provides guidance for assessing the vulnerabilities of California's watersheds and regions to climate change impacts and prioritizing these vulnerabilities.

The State has developed additional tools and resources to assist resource managers and local agencies in adapting to climate change, including:

- *California Climate Adaptation Strategy (2009)* - California Natural Resources Agency at http://www.climatechange.ca.gov/adaptation/strategy/index.html.
- *California Climate Adaptation Planning Guide (2012)* - California Emergency Management Agency and California Natural Resources Agency at http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html.
- *Cal-Adapt* Web site at http://cal-adapt.org/.
- *Urban Forest Management Plan (UFMP) Toolkit* - sponsored by the California Department of Forestry and Fire Protection at http://ufmptoolkit.com/.
- *California Climate Change Portal* at http://www.climatechange.ca.gov/.
- *DWR Climate Change* Web site at http://www.water.ca.gov/climatechange/resources.cfm.
- *The Governor's Office of Planning and Research* Web site at http://www.opr.ca.gov/m_climatechange.php.

In addition, many of the resource management strategies found in Volume 3 not only assist in meeting water management objectives, but also provide benefits for adapting to climate change. These include:

- Chapter 2, "Agricultural Water Use Efficiency."
- Chapter 4, "Flood Management."
- Chapter 5, "Conveyance – Delta."
- Chapter 7, "System Reoperation."
- Chapter 13, "Surface Storage – CALFED."
- Chapter 17, "Matching Water Quality to Use."
- Chapter 18, " Pollution Prevention."
- Chapter 21, "Agricultural Lands Stewardship."
- Chapter 22, "Ecosystem Restoration."
- Chapter 24, "Land Use Planning and Management."
- Chapter 27, "Watershed Management."

The myriad of resources and choices available to water managers can seem overwhelming. However, managers can implement many proven strategies to prepare for climate change in the Delta region, regardless of the magnitude of future warming. These strategies often provide multiple benefits. For example, wetland restoration not only provides habitat for at-risk species, but can help improve water quality, attenuate waves associated with storm surges, and sequester carbon. Other adaptation measures include setback levees, reinforcing or armoring of levees, floodplain restoration, riparian restoration, especially at the toe of levees, and subsidence reversal.

Water managers need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystems, which can benefit humans via carbon sequestration, pollution remediation, and flood risk reduction. Increased collaboration between water managers, land use planners, and ecosystem managers can identify common goals and actions that are needed to achieve resilience to climate change and other stressors. While both adaptation and mitigation are needed to manage climate change risks and often are complementary, unintended consequences may arise if efforts are not coordinated (CNRA 2009).

Climate Change Mitigation

Energy intensity in this overlay region is evaluated in the Sacramento, San Joaquin, and San Francisco regional reports.

Ecosystem Services

A pilot project of integrated regional water management that includes enhancement of biological diversity among its goals is presented below. One of the aims of the pilot project is to recognize the economic value of the goods and services that nature provides and to incorporate that value into natural resource management decisions. Such recognition includes development of ways to measure the economic value of those services. This can be important information for water managers who normally see only the costs of ecosystem protection and restoration, but not the benefits, in their budgets. The services considered in this project are carbon sequestration for GHG mitigation, land subsidence reversal, and wildlife.

This project constitutes on-the-ground efforts to advance several of the objectives in the implementation plan of Update 2009. In particular, it aims to expand environmental stewardship (objective 5), practice integrated flood management (objective 6), and manage a sustainable California Delta (objective 7).

The project goes beyond most watershed management efforts by laying the foundation for establishment of markets to buy and sell units of nature's services, that is, mechanisms for beneficiaries to pay for goods and services they receive. This requires some sort of assessment of the monetary value of the benefits. The desired end product is to put payments in the hands of producers — resource managers — as an incentive to keep them producing.

Carbon Capture Farming in the Delta Pilot Project

The Sacramento-San Joaquin Delta is a critical natural resource, an important agricultural region, and a major hub for California's water supply. Over the past century, agricultural practices in the Delta have caused the loss of more than two maf of peat soils, causing land to subside down to 20 feet or more below sea level on several islands in the west and central Delta (Mount and Twiss 2005). Current agricultural practices continue to remove these soils and, as part of that loss, emit about 5 million tons of carbon dioxide annually — about one percent of California's total emissions (Merrill et al. 2010). Peat soil can generate unusually large amounts of GHGs because it is a natural storehouse of enormous amounts of carbon.

Land subsidence contributes to the risk of failure of the levees that protect the islands (DWR 1986; DWR 1989). The levees protect farmland and maintain a supply of water to 25 million people and three million acres of irrigated farmland outside the Delta. Land subsidence increases the hydraulic stress on levees, making them leakier and more likely to fail, and increases the volume of water that could be taken up by an island in the event of a levee break (Mount and Twiss 2005). In turn, a levee break could allow a pulse of brackish or salt water to invade the Delta and compromise water quality for most uses.

Subsidence reversal should reduce the cost of maintenance of levees on subsided islands and provide better protection for a vast array of infrastructure including roads, railroads, bridges, airports, ferries, electricity transmission lines, natural gas pipelines, oil and gas production fields, marinas, aqueducts, and towns. Two land management options, referred to as carbon capture wetland farms and low carbon agriculture, could reduce soil loss and greenhouse gas emissions, reduce the many risks associated with land subsidence, and provide habitat benefits to the Delta ecosystem (Merrill et al. 2010).

Carbon capture wetland farms are constructed wetlands operated to maximize retention of atmospheric carbon, mainly in the soil, and minimize the release of other GHGs. Native tule wetlands, in particular, can capture and store carbon at very high rates and, in doing so, build soil that significantly and continuously reverses subsidence (Merrill et al. 2010).

Low carbon agriculture refers to farming practices that reduce GHG emissions and rates of ongoing land subsidence. They could be applied to conventional crops, or in combination with tule wetland farms. These practices could include increasing groundwater levels during the growing and fallow seasons, winter flooding, reduced tillage, soil nutrient management that does not rely on nitrogen-based synthetic fertilizer, and conversion to rice production.

Research on tule wetlands in the Delta shows that a combination of increases in carbon sequestration and prevented soil carbon loss could reduce greenhouse gas emissions by 10 to 35 metric tons of CO_2 equivalents per year (Merrill et al. 2010). The reductions could continue to accrue over a period of 50 to 100 years or so, depending on initial subsided land elevations. Studies in the Delta have shown that land elevations increased by an average of 4 cm/yr from accumulation of material from wetlands (Miller et al. 2008). Subsidence reversal from this accretion would directly improve levee stability through reduced hydrostatic pressure. Restoring wetland habitats could also benefit native wildlife, including waterfowl, the threatened giant garter snake, and many other species.

Wetland water management calls for maintaining saturated conditions in more of the soil profile for a greater amount of time than in conventional farming. This prolonged soil saturation reduces decomposition rates of plant material and GHG emissions that result from the decomposition.

A pilot project on Twitchell Island, conducted by U.S. Geological Survey and DWR, provided much of the foundational science about carbon budgets on Delta islands. Originally this was a study of the potential for subsidence reversal, the project directly measured GHG fluxes in tule wetlands and adjacent control sites, which were conventionally managed corn fields. Overall effects on GHG storage and release were driven both by carbon capture in the wetlands and by large GHG emissions from corn fields. That is, the conversion of annual cropland to wetlands both sequestered a large amount of carbon dioxide and prevented the GHG emissions caused by plowing, drying, and fertilizing peat soil.

Growers of tule wetlands could earn revenue from the sale of carbon credits. AB 32, the Global Warming Solutions Act, mandates large reductions in GHG emissions in California. One likely method to reduce emissions is through a market in carbon offset credits. Economic models are under development to project break-even costs for replacing conventional farmland with wetlands. Preliminary findings are that carbon capture wetlands might become financially viable when carbon prices reach about $20 per metric ton. This break-even price excludes unknown or highly variable factors, such as land acquisition and costs of verification of GHG credits.

The potential for carbon-capture wetlands and other low-carbon farming methods to provide so many benefits — wildlife habitat, flood protection and public safety, reliable water quality and supply, greenhouse gas mitigation, jobs and income for farmers — has attracted attention from several quarters. A comprehensive study performed jointly by The Nature Conservancy, Environmental Defense Fund, Wetlands and Water Resources, Inc., and Stillwater Sciences titled (*Greenhouse Gas Reduction and Environmental Benefits in the Sacramento-San Joaquin Delta: Advancing Carbon-capture Wetland Farms and Exploring Potential for Low Carbon Agriculture* in 2011 concluded that the benefits of carbon capture wetland farming are established well enough to prompt the next step, farm-scale demonstration projects. These would involve technical studies to develop protocols to measure carbon offsets, including GHG fluxes and overall carbon budgets. Studies also would address potential adverse impacts, including contamination from mercury and dissolved organic carbon and the need for mosquito control.

DWR has formed a partnership with The Nature Conservancy and Environmental Defense Fund to locate and fund a larger, 200- to 400-acre site in the Delta for feasibility testing at the farm scale. A demonstration project could examine both the costs and GHG emissions from a menu of management practices, including winter flooding, low-carbon agriculture, rice production, tule farms, and wetlands designed for waterfowl and waterfowl hunters. Potential partners include Metropolitan Water District, Irvine Ranch Water District, Sacramento Municipal Utility District, Pacific Gas and Electric Company, and the Delta Conservancy.

Meanwhile, DWR has established a 305-acre project to grow tules on Sherman Island to measure carbon budgets and enhance habitat features. Enhancements include provision of open water without tules preferred by waterfowl, islands for bird nesting, and introduction of fish for mosquito control. DWR also has constructed a 300-acre rice research project on Twitchell Island to study subsidence reversal, carbon sequestration, effects on methyl mercury and certain agricultural chemicals, and economic feasibility.

Resource Management Strategies

Resources management strategies are detailed in Volume 3 of Update 2013. A number of these strategies will be useful in improving the management of water for use within the Delta as well as tackling other challenges. Table D-7 lists the resource management strategies that appear applicable in the Delta based on regional studies. Several efforts under way may potentially implement a number of these resource management strategies.

PLACEHOLDER Table D-7 Resource Management Strategies and Delta Actions

[Any draft tables, figures, and boxes that are available to accompany this text for the public review draft are included at the end of the regional report.]

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Table D-1 Agencies with Responsibilities in the Delta and Suisun Marsh

STATE	
Delta Stewardship Council	Established in 2009 by the Delta Reform Act to further the achievement of the coequal goals through the development and implementation of a legally enforceable Delta Plan.
Delta Conservancy	Established by the Delta Reform Act to serve as a primary State agency to implement ecosystem restoration in the Delta and support efforts that advance environmental protection and economic well being of Delta residents.
Delta Protection Commission	Prepares a long-term resource management plan for land uses within the primary zone of the Delta and is required by the Delta Reform Act to develop an economic sustainability plan for the Delta.
Office of the Delta Watermaster	Created in 2009 by the Delta Reform Act to oversee day-to-day administration of water rights, enforcement activities, and reports on water right activities regarding diversions in the Delta.
California Department of Fish and Wildlife	Fish and wildlife protection, including issuance of permits and actions to restore habitats.
California Department of Water Resources	Owns and operates the State Water Project, has emergency response and flood planning responsibilities, holds water quality/supply contracts with Delta water agencies, and coordinates overall statewide water planning.
State Water Resources Control Board	Responsible for developing and implementing the Bay-Delta Water Quality Control Plan to establish water quality objectives, including flow objectives, to ensure reasonable protection of beneficial uses in the Bay-Delta. Responsible for establishing, implementing, and enforcing water right requirements to ensure the proper allocation and efficient use of water in and out of the Delta, including the role of the Delta Watermaster. With regional boards, responsible for developing and implementing other water quality standards and control plans consistent with State and federal laws to reasonably protect aquatic beneficial uses.
Central Valley Flood Protection Board	Plans flood control along the Sacramento and San Joaquin rivers and their tributaries in cooperation with the U.S. Army Corps of Engineers.
California Natural Resources Agency	In coordination with a group of local water agencies, environmental and conservation organizations, State and federal agencies, and other interest groups, developing the Bay Delta Conservation Plan.
Other state agencies	Have various roles or responsibilities in the Delta relevant to the agency's concern (for example, Department of Food and Agriculture, Department of Transportation, State Parks, Boating and Waterways, State Lands Commission, California Environmental Management Agency, and others).
FEDERAL	
U.S. Bureau of Reclamation	Owns and operates the Central Valley Project, which, among other activities, pumps water through and out of the Delta.
U.S. Fish and Wildlife Service	Develops plans for the conservation and recovery of fish and wildlife resources and addresses the variable needs of fish and wildlife pursuant to the Endangered Species Act.
U.S. Army Corps of Engineers	Involved with both federal and non-federal partners in assessing channel navigation, ecosystem, and flood risk management projects in the Delta. Works cooperatively with its non-federal partners regarding the regulation, maintenance, and improvement of project levees in the Delta.
National Marine Fisheries Service	Develops plans for the conservation and recovery of salmonids in the Delta pursuant to the Endangered Species Act.
U.S. Environmental Protection Agency	Responsible for protection and restoration of water quality in the Delta, pursuant to the Clean Water Act (CWA), which regulates the discharge of pollutants into waterways and sets standards for water quality. Oversees implementation of CWA programs and policies delegated to the State.
Other federal agencies	Various roles or responsibilities in the Delta relevant to the agency's concern (for example, U.S. Department of Agriculture, Natural Resources Conservation Service, and others).
LOCAL	
Hundreds of local reclamation districts, resource conservation districts, water districts, city and county governments, and other special districts.	

Source: Modified from Table 2-1 in the Final Draft Delta Plan (DSC 2012)

Table D-2 Laws, Directives, and Orders Affecting CVP and SWP Operations

Laws, Directives, and Orders	Year	Description
Delta Protection Act	1959	Ensures water is available for in-Delta beneficial uses.
North Delta Water Agency	1981	Contract that ensures there will be suitable water in the Northern Delta for agriculture and other beneficial uses.
Coordinated Operating Agreement	1986	Agreement between the State and feds to determine the respective water supplies of the CVP and SWP while allowing for a negotiated sharing of Delta excess outflows and the satisfaction of in-basin obligations between the projects
SWRCB Orders 90-5, 91-1	1990, 1991	Modified Reclamation water rights to incorporate temperature control objectives in the Upper Sacramento River
NMFS BO for Winter-run Chinook Salmon	1992, 1993, 1995, 2009	Established operation to protect winter-run and provided for “incidental taking”
CVPIA	1992	Mandated changes to the CVP particularly for the protection, restoration and enhancement of fish and wildlife
FWS BO for Delta Smelt and Sacramento Splittail	1993, 1994, 1995, 2008	Established operational criteria to protect Delta Smelt
Bay-Delta Plan Accord and SWRCB Order WR 95-06	1994, 1995	Agreement and associated SWRCB order to provide for the operations of the CVP and SWP to protect Bay-Delta water quality. Also provided for development of a new Bay-Delta operating agreement (being pursued through CALFED)
Monterey Agreement	1995	Agreement between DWR and SWP contractors to manage contractor operations
SWRCB Revised Water Right Decision 1641	2000	Revised order to provide for operations of the CVP and SWP to protect Delta water quality
CALFED ROD	2000	Presented a long-term plan and strategy designed to fix the Bay-Delta
CVPIA ROD	2001	Implemented provisions of CVPIA including allocating 800,000 acre-feet of CVP yield for environmental purposes
NMFS BO for Spring-run Chinook Salmon and Steelhead	2001, 2002, 2004, 2009	Established criteria for operations to protect spring-run Chinook salmon and steelhead
SWRCB Order 2006-0006	2006	Draft Cease and Desist Order against DWR and Reclamation

Source: Table entries in part are excerpts from Table 1-1 of the June 2004 CVP-OCAP available at: http://www.usbr.gov/mp/cvo/ocapBA.html

Table D-3 Summary of Community Drinking Water Systems in the Sacramento-San Joaquin Delta Region that Rely on One or More Contaminated Groundwater Wells that Exceeds a Primary Drinking Water Standard

Community Drinking Water Systems and Groundwater Wells Grouped by Water System Population	No. of Affected Community Drinking Water Systems	No. of Affected Community Drinking Water Wells
Small System ≤ 3,300	18	23
Medium System 3,301 - 10,000	1	2
Large System ≥ 10,000	2	2
Total	21	27

Source: Water Boards 2012 Draft Report *Communities that Rely on Contaminated Groundwater*

Table D-4 Summary of Contaminants Affecting Community Drinking Water Systems in the Sacramento-San Joaquin Delta Region

Principal Contaminant (PC)	Community Drinking Water Systems where PC exceeds the Primary MCL	No. of Community Drinking Water Wells where PC exceeds the Primary MCL
Arsenic	17	22
Nitrate	2	2
Gross alpha particle activity	1	2
Fluoride	1	1
Uranium	1	1

Source: Water Boards 2012 Draft Report *Communities that Rely on Contaminated Groundwater*

Table D-5 Sacramento-San Joaquin Delta Area Exposures within the 100-Year and 500-Year Floodplains

Segment Exposed	1% (100-year) Floodplain	0.2% (500-year) Floodplain
Population, % total exposed	59,300, 13%	218,100, 47%
Structure and Content Value	$6.1 billion	$18.0 billion
Crop Value	$683 million	$1.0 billion
Tribal Lands (acres)	0	0
Essential Facilities (count)	20	92
High Potential-Loss Facilities (count)	19	47
Lifeline Utilities (count)	4	13
Transportation Facilities (count)	134	251
Department of Defense Facilities (count)	2	2
State and Federal Threatened, Endangered, Listed, and Rare Plants [a]	46	46
State and Federal Threatened, Endangered, Listed, and Rare Animals [a]	61	64

Source: SFMP California's Flood Future Report.

[a] Many Sensitive Species have multiple occurrences throughout the state and some have very large geographic footprints that may overlap more than one analysis region. As a result, a single Sensitive Species could be counted in more than one analysis region. Because of this the reported statewide totals will be less than the sum of the individual analyses regions.

Table D-6 Expected Completion for IRWM Plans

IRWM Region	Expected Completion Date
American River Basin IRWM Plan	January 2013
East Contra Costa County IRWM Plan	December 2012
Eastern San Joaquin IRWM Plan	February 2013
San Francisco Bay IRWM Plan	October 2013
Westside – Yolo/Solano/Napa/Lake/Colusa IRWM Plan	October 2013

Table D-7 Resource Management Strategies and Delta Actions

	Actions						
Resource Management Strategies	Delta Plan	BDCP	CVFPP	Suisun Marsh Plan	Strategic Workplan	General Plans	IRWMP
Reduce Water Demand							
Agricultural Water Use Efficiency	√				√	√	√
Urban Water Use Efficiency	√				√	√	√
Improve Operational Efficiency and Transfers							
Conveyance Delta	√	√					
Conveyance Regional/Local	√	√		√	√	√	√
System Re-operation	√	√		√	√		√
Water Transfers	√	√			√	√	√
Increased Water Supply							
Conjunctive Management and Groundwater Storage	√	√	√		√	√	√
Desalination – Brackish and Seawater	√						√
Precipitation Enhancement							
Recycled Municipal Water	√				√	√	√
Surface Storage – CALFED	√						√
Surface Storage – Regional/Local	√					√	√
Improve Water Quality							
Drinking Water Treatment and Distribution	√				√	√	√
Groundwater/Aquifer Remediation	√					√	√
Matching Water Quality to Use					√	√	√
Pollution Prevention	√				√	√	√
Salt and Salinity Management	√	√		√	√	√	√
Urban Runoff Management	√				√	√	√

	Actions						
Resource Management Strategies	Delta Plan	BDCP	CVFPP	Suisun Marsh Plan	Strategic Workplan	General Plans	IRWMP
Practice Resource Stewardship							
Agricultural Lands Stewardship	√	√	√	√		√	√
Economic Incentives	√		√		√	√	√
Ecosystem Restoration	√	√	√	√	√	√	√
Forest Management							√
Land Use Planning and Management	√		√	√	√	√	√
Recharge Areas Protection	√		√		√	√	√
Water-Dependent Recreation	√			√	√	√	√
Watershed Management	√				√	√	√
Improve Flood Management							
Flood Risk Management	√		√			√	√
Other Strategies							
Sediment Management							
Outreach and Education							
Cultural Water Management							

Figure D-1 Sacramento-San Joaquin Delta Inflows and Outflows in 2010

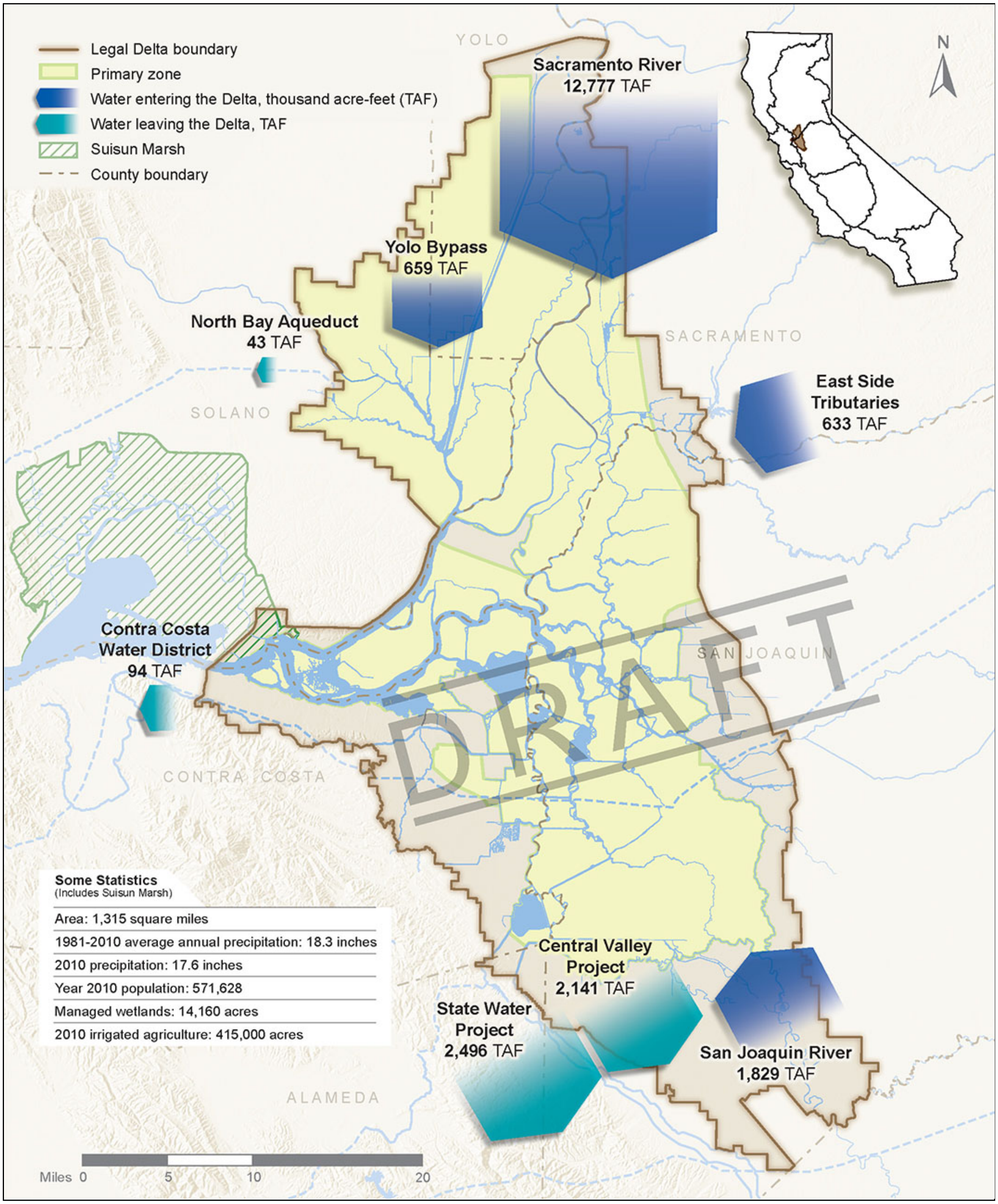
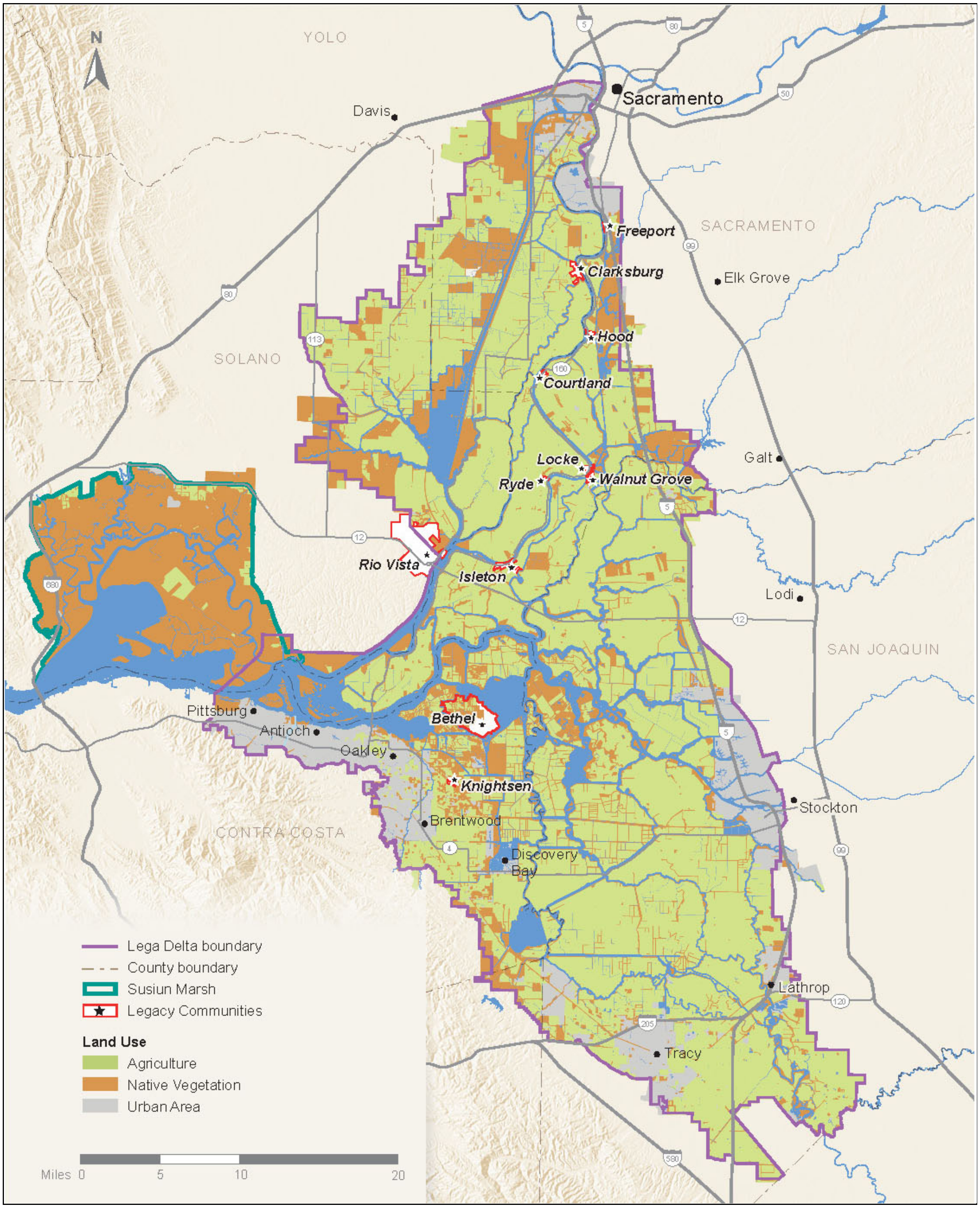


Figure D-2 Sacramento-San Joaquin Delta Watershed

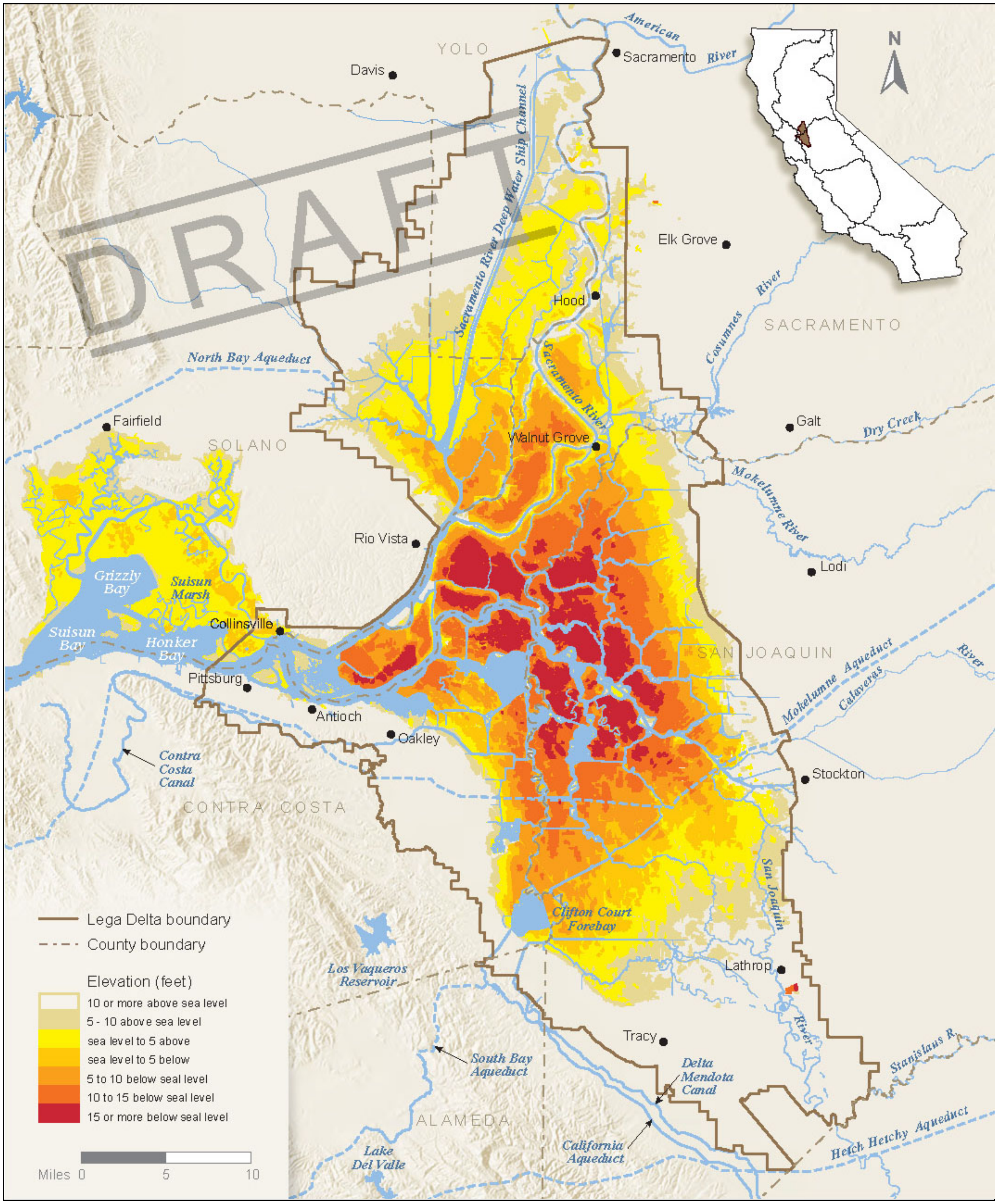
Figure D-3 Delta Resources



PLACEHOLDER Photo D-1 Recreating in the Delta

[photo to come]

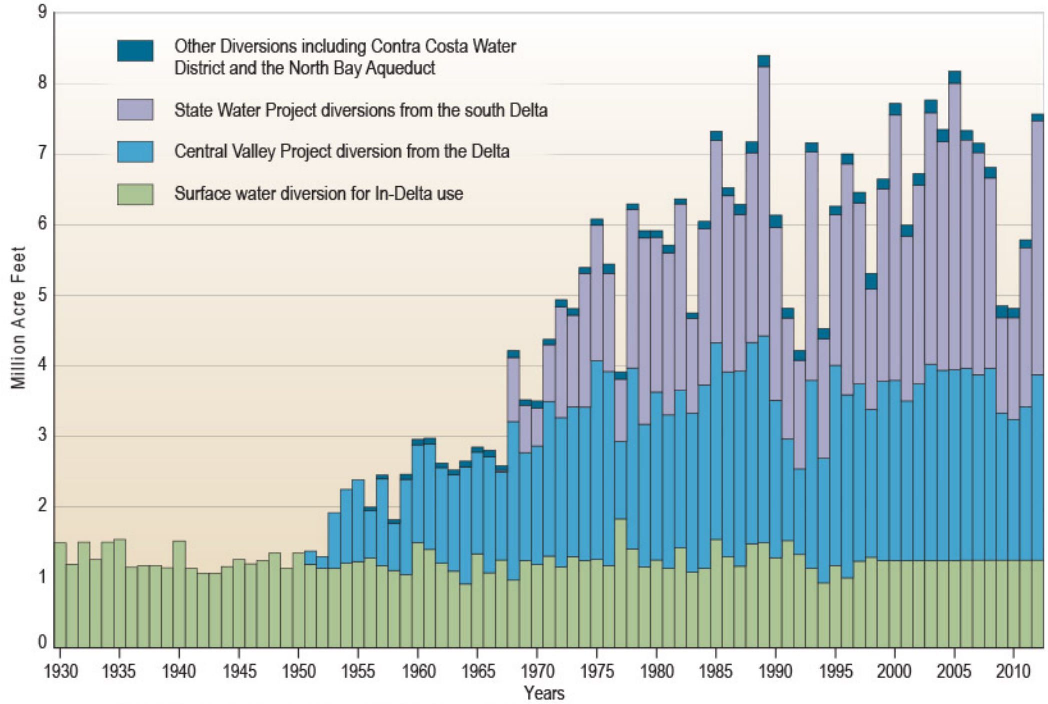
Figure D-4 Land Subsidence in the Delta



PLACEHOLDER Photo D-2 Suisun Marsh

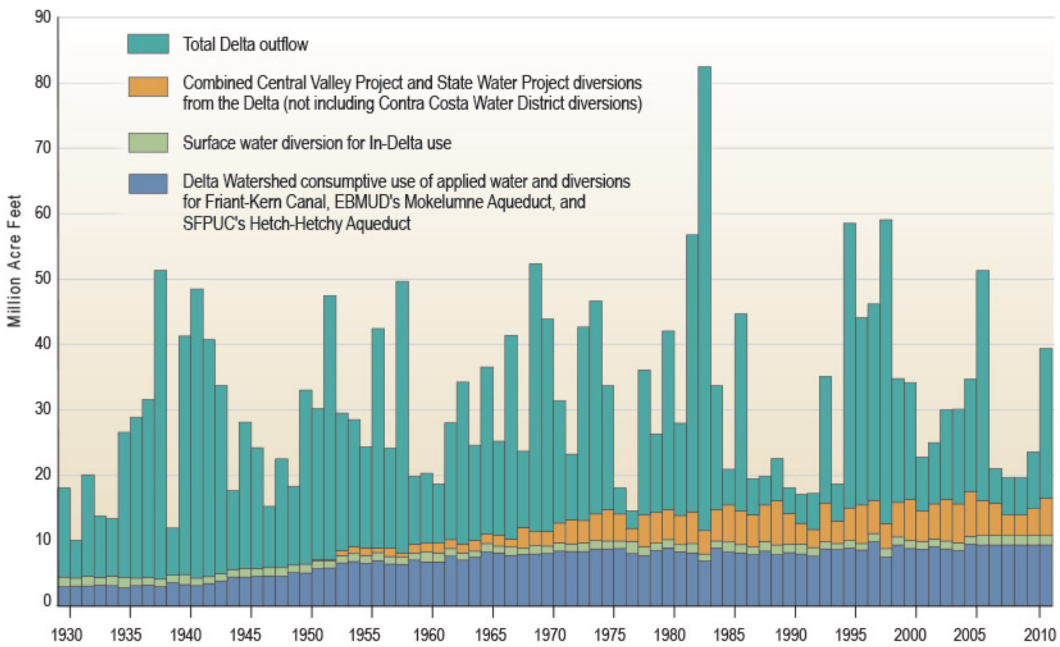
[photo to come]

Figure D-5 Historical Diversions from within the Delta



Source: Delta Vision Blue Ribbon Task Force 2008 Final Report; DWR 2012

Figure D-6 Historical Diversions before the Delta, In-Delta Uses and Exports from the Delta, Plus Outflows



Trends in Destinations and Uses

Period	Average Annual Total (MAF)	Outflow	in-Delta	Exports	Delta Watershed
1930 to 1949	25.80	81%	5%	0%	14%
1990 to 2005	31.71	67%	4%	4%	24%
1950 to 1969	34.34	51%	5%	15%	29%
1970 to 1989	32.85	48%	4%	17%	31%

Source: Delta Vision Blue Ribbon Task Force. 2008. Final Report.

PLACEHOLDER Figure D-7 Delta Water Balance for Years 1998, 2000, and 2001

[figure to come]

Figure D-8 Location of State Water Project and Central Valley Project Facilities in the Delta-Suisun Area

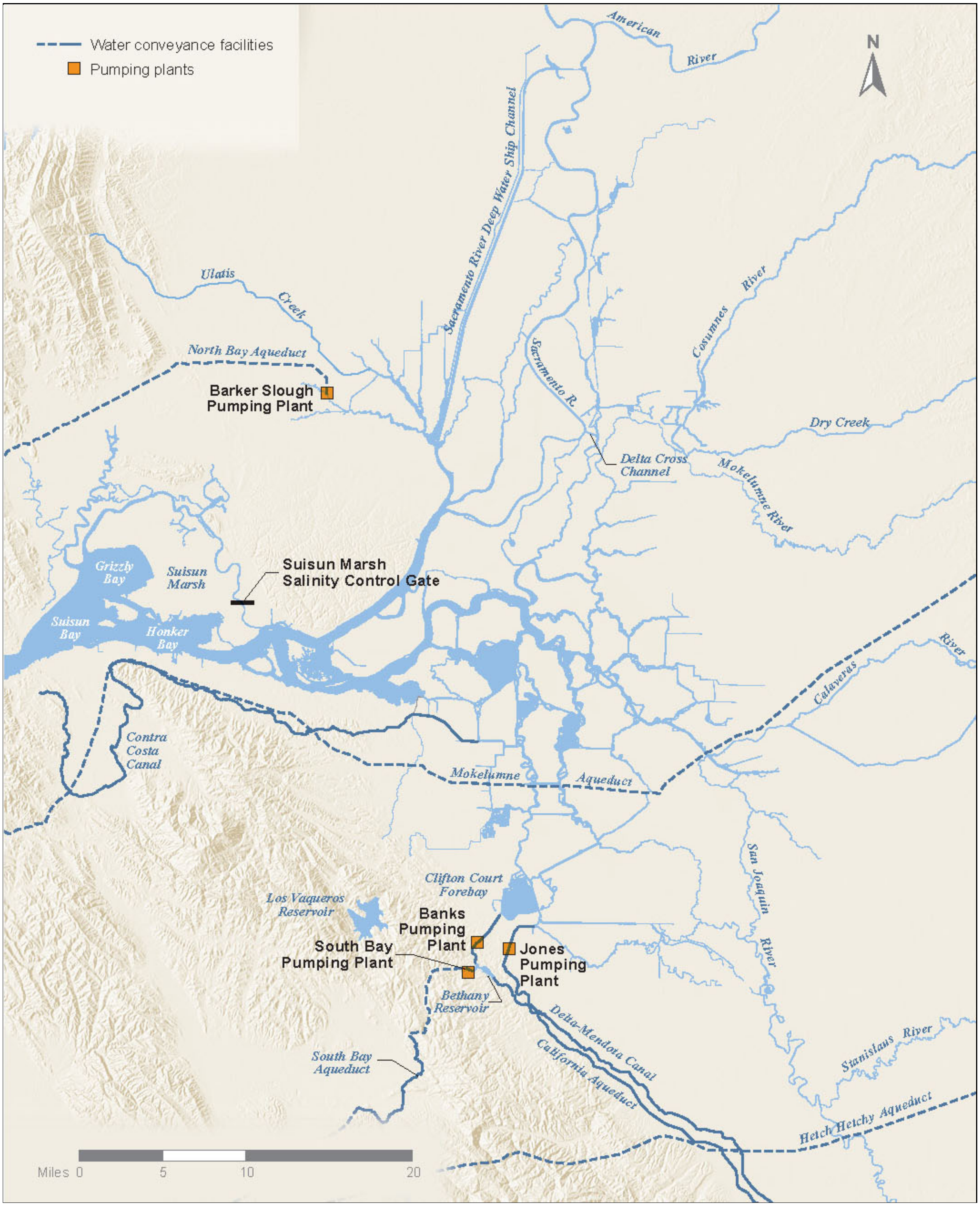
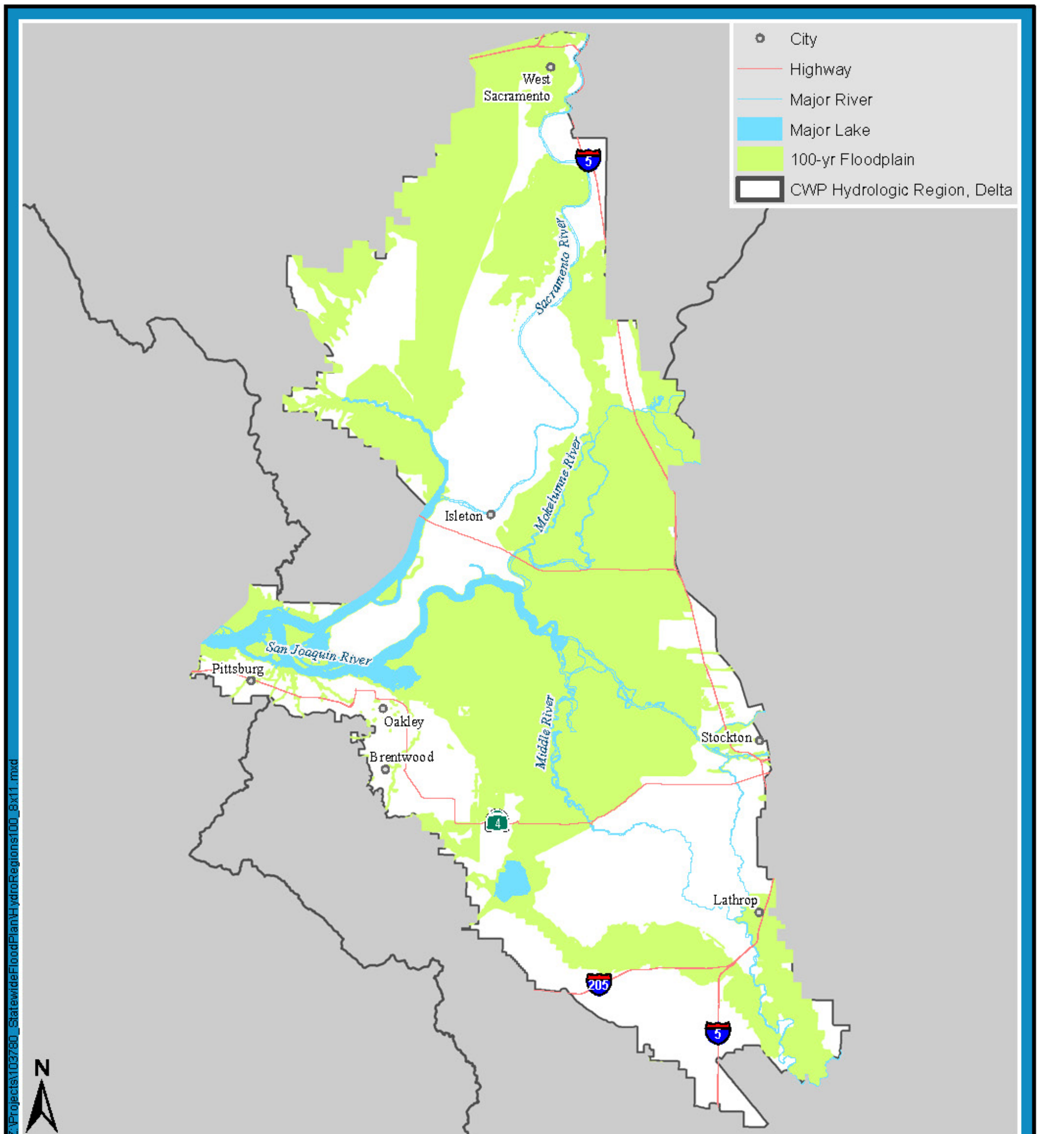


Figure D-9 Flood Hazard Exposure to the 100-Year Floodplain in the Sacramento-San Joaquin Delta



Delta Key Results

Total Population:	461,800	Transportation Facilities:	134
Population Exposed:	59,300	Transportation Segments (miles):	135
Percent of Population Exposed:	13	Essential Facilities:	20
Exposed Structures:	23,800	Lifeline Utilities:	4
Value of Exposed Structure and Contents:	$6.1 Billion	Dept. of Defense Facilities:	2
Total Area (acres)	737,700	Dept. of Defense Facilities (acres):	34
Exposed Area (acres)	389,000	High Potential Loss Facilities:	19
Percent of Area Exposed:	53	Native American Tribes:	-
Exposed Ag.Crops (acres):	248,900	Native American Tribal Lands (acres):	-
Percent of Ag. Crops Exposed:	51	Sensitive Animal Species Exposed:	61
Value of Exposed Ag. Crops:	$682.7 Million	Sensitive Plant Species Exposed:	46

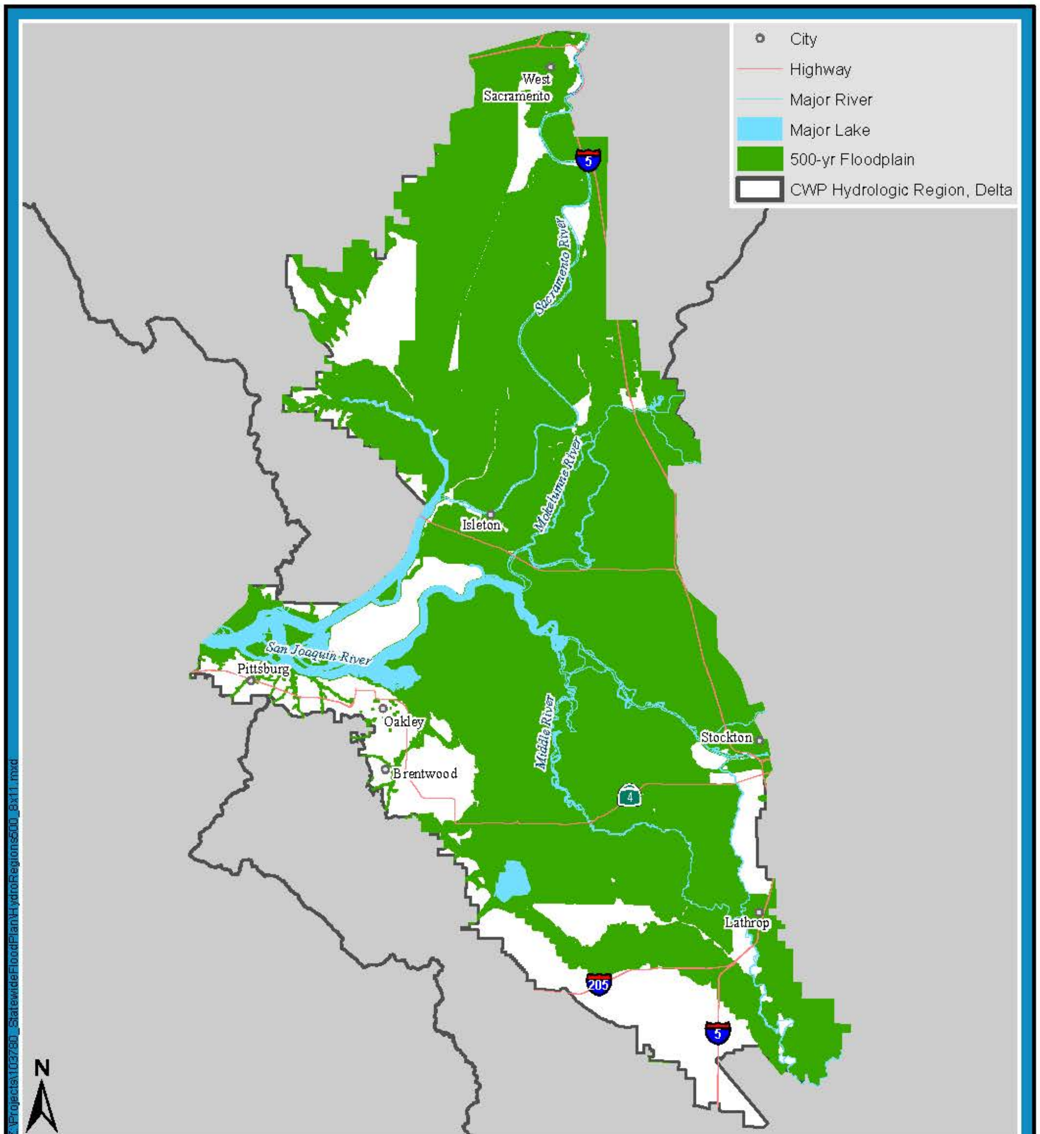
Statewide Flood Hazard Exposure Summary for the Sacramento-San Joaquin Delta Region 100-year Floodplain

STATEWIDE FLOOD MANAGEMENT PLANNING PROGRAM

FloodSAFE CALIFORNIA

Jan 28, 2013

Figure D-10 Flood Hazard Exposure to the 500-Year Floodplain in the Sacramento-San Joaquin Delta



Delta Key Results

Total Population:	461,800	Transportation Facilities:	251
Population Exposed:	218,100	Transportation Segments (miles):	246
Percent of Population Exposed:	47	Essential Facilities:	92
Exposed Structures:	74,500	Lifeline Utilities:	13
Value of Exposed Structure and Contents:	$18.0 Billion	Dept. of Defense Facilities:	2
Total Area (acres)	737,700	Dept. of Defense Facilities (acres):	52
Exposed Area (acres)	553,100	High Potential Loss Facilities:	47
Percent of Area Exposed:	75	Native American Tribes:	-
Exposed Ag.Crops (acres):	383,000	Native American Tribal Lands (acres):	-
Percent of Ag. Crops Exposed:	78	Sensitive Animal Species Exposed:	64
Value of Exposed Ag. Crops:	$1.0 Billion	Sensitive Plant Species Exposed:	46

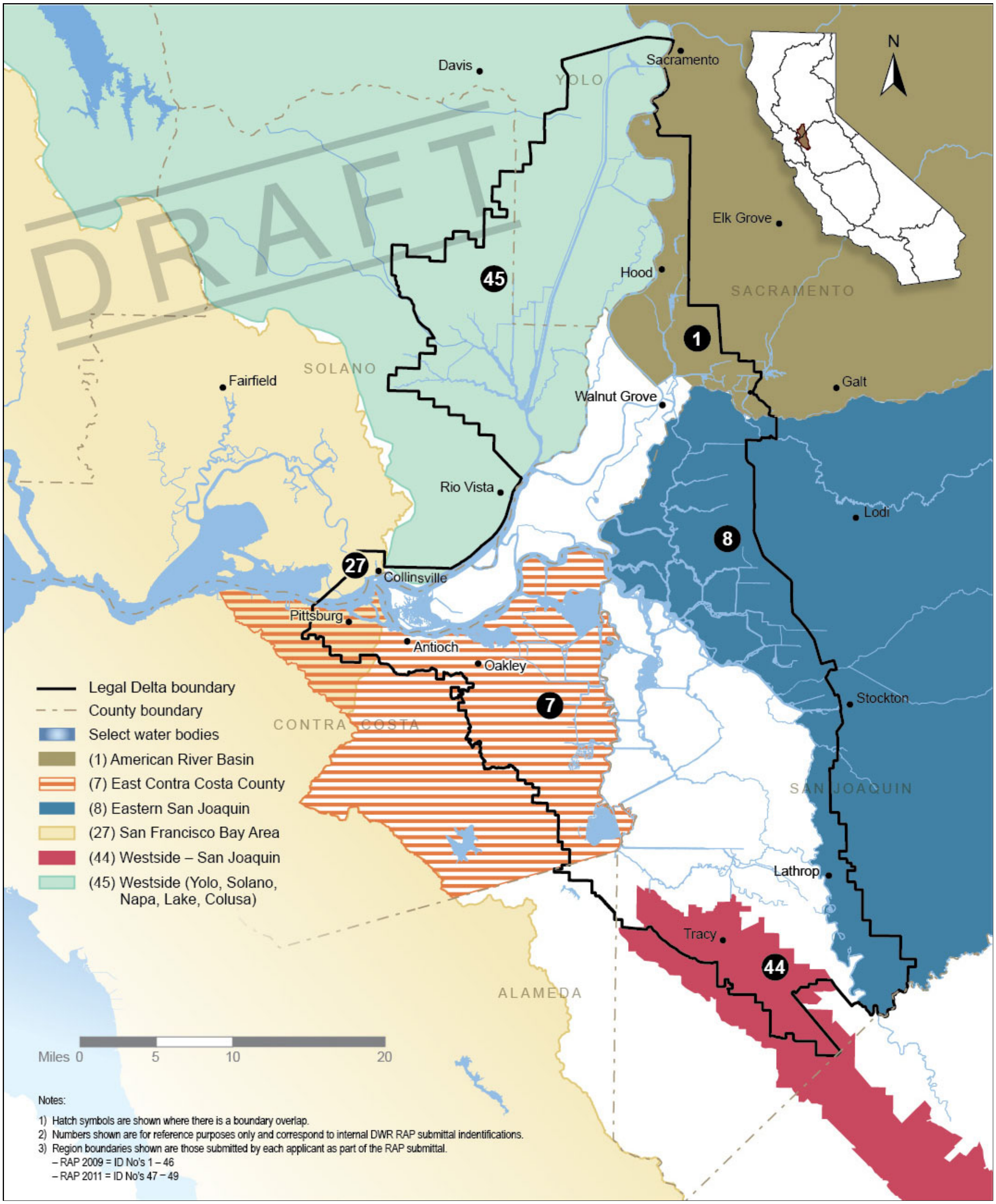
Statewide Flood Hazard Exposure Summary for the Sacramento-San Joaquin Delta Region 500-year Floodplain

STATEWIDE FLOOD MANAGEMENT PLANNING PROGRAM

FloodSAFE CALIFORNIA

Jan 28, 2013

Figure D-11 Regional Acceptance Process IRWM Regions, Sacramento-San Joaquin Delta



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Acronyms and Abbreviations Used in This Report

ABAG	Association of Bay Area Governments
ACWA	Association of California Water Agencies
ACWD	Alameda County Water District
AHPS	Advanced Hydrologic Prediction Service
ARP	Aquifer Reclamation Program
ASR	aquifer storage and recovery
BAAQMD	Bay Area Air Quality Management District
BACWA	Bay Area Clean Water Agencies
BAFPAA	Bay Area Flood Protection Agencies Association
BART	Bay Area Rapid Transit
BASMAA	Bay Area Stormwater Management Agencies Association
BAWAC	Bay Area Water Agencies Coalition
Bay Area IRWMP	San Francisco Bay Area IRWMP
Bay Region	San Francisco Bay Hydrologic Region
BCDC	Bay Conservation and Development Commission
BMO	Basin Management Objective
Cal EMA	California Emergency Management Agency
CASGEM	California Statewide Groundwater Elevation Monitoring
CC	Coordinating Committee
CCWD	Contra Costa Water District
CDPH	California Department of Public Health
CCCSD	Central Contra Costa Sanitary District
CNRA	California Natural Resources Agency
COG	Council of Government
CRS	Community Rating System
CVP	Central Valley Project
DAC	disadvantaged community
Delta	Sacramento-San Joaquin River Delta
DFW	California Department of Fish and Wildlife
DPR	Department of Pesticide Regulation
DSRSD	Dublin San Ramon Service District
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utilities District
ECCC IRWMP	East Contra Costa County IRWMP
EI	energy intensity
ERP	Ecosystem Restoration Program
FCWCD	Flood Control and Water Conservation District
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GAMA	Groundwater Ambient Monitoring and Assessment
GHG	greenhouse gas
gpd	gallons per day
gpm	gallons per minute

GWMP	groundwater management plan
HIP	high population scenario
IRWMP	integrated regional water management plan
JPC	Joint Policy Committee
LGVSD	Las Gallinas Valley Sanitary District
LID	Low-Impact Development
LLNL	Lawrence Livermore National Laboratory
LOP	low population growth scenario
maf	million acre-feet
mgd	million gallons per day
MHI	median household income
MMWD	Marin Municipal Water District
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
MWh	megawatt-hour
NBA	North Bay Aqueduct
NFIP	National Flood Insurance Program
NMWD	Novato Sanitary District/North Marin Water District
NOAA Fisheries	National Oceanic and Atmospheric Administration Fisheries
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
OPR	Governor's Office of Planning and Research
PA 201	North Bay Planning Area
PDA	Priority Development Area
RWQCB	Regional Water Quality Control Board
SBA	South Bay Aqueduct
SBWR	South Bay Water Recycling
SCVWD	Santa Clara Valley Water District
SCWA	Sonoma County Water Agency
SFBJV	San Francisco Bay Joint Venture
SFEI	San Francisco Estuary Institute
SFPUC	San Francisco Public Utilities Commission
SFRWQCB	San Francisco Regional Water Quality Control Board
SVCSD	Sonoma Valley County Sanitation District
SWN	State Well Number System
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf	thousand acre-feet
TMDL	total maximum daily load
UFMP	Urban Forest Management Plan
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
Zone	Zone 7 Water Agency

San Francisco Bay Hydrologic Region

San Francisco Bay Hydrologic Summary

The San Francisco Bay Hydrologic Region (Bay Region) occupies approximately 4,500 square miles; from southern Santa Clara County to Tomales Bay in Marin County; and inland to the confluence of the Sacramento and San Joaquin rivers near Collinsville. The region has many significant water management challenges — sustaining water supply, water quality, and the ecosystems in and around San Francisco Bay; reducing flood damages; and adapting to impacts from climate change. A thorough discussion of climate change is presented including precipitation variability, reduced snowpack accumulation in the Sierra Nevada, and vulnerability of developed bay and coastal areas to sea level rise. However, with strong water planning and governance and several resource management strategies that can be applied, the region is poised to address these challenges effectively.

PLACEHOLDER Table SFB-1 Water Governance, San Francisco Bay Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Current State of the Region

Setting

The Bay Region includes all of San Francisco County and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties. It occupies approximately 4,500 square miles from southern Santa Clara County to Tomales Bay in Marin County and inland to the confluence of the Sacramento and San Joaquin rivers at the eastern end of Suisun Bay (Figure SFB-1). The eastern boundary follows the crest of the Coast Ranges; where the highest peaks are more than 4,000 feet above mean sea level.

PLACEHOLDER Figure SFB-1 Map of the San Francisco Bay Hydrologic Region

For nearly a century, water agencies in the region have relied on importing water from the Sierra Nevada to supply their customers. Water from the Mokelumne and Tuolumne rivers accounts for about 38 percent of the region's average annual water supply. Water from the Sacramento-San Joaquin River Delta (Delta) via the federal Central Valley Project (CVP) and the State Water Project (SWP) accounts for another 28 percent. Approximately 31 percent of the average annual water supply is from local groundwater and surface water, and 3 percent is from miscellaneous sources such as harvested rainwater, recycled water, and transferred water. Population growth and diminishing water supply and water quality have led to the development of local surface water supplies, recharge of groundwater basins, and incorporation of conservation guidelines to sustain water supply and water quality for future generations.

The Sacramento and San Joaquin rivers flow into the Delta and into San Francisco Bay. The Delta is the largest estuary on the West Coast, receiving nearly 40 percent of the state's surface water from the Sierra Nevada and the Central Valley. The interaction between Delta outflow and Pacific Ocean tides determines how far salt water intrudes into the Delta. The resulting salinity distribution influences the distribution of many estuarine fish and invertebrates, as well as the distribution of plants, birds, and animals in wetlands areas. Delta outflow varies with precipitation, reservoir releases, and upstream diversions. An average of 18.4 million acre-feet (maf) of freshwater flows out of the Delta annually into the bay (California Data Exchange Center [CDEC] 2000–2008). Daily tidal flux through the Carquinez Strait is much greater than the freshwater flows.

The Bay Region boasts significant Pacific Coast marshes such as the Pescadero and Tomales Bay marshes, as well as San Francisco Bay itself. San Francisco Bay is relatively shallow, with 85 percent of its area less than 30-feet deep. Much of the perimeter of the bay is shallow tidal mud flats, tidal marshes, diked or leveed agricultural areas, and salt ponds. These tidal baylands support important aquatic and wetland habitats and have been the focus of many restoration activities over the past 30 years. The physical extent of the bay in the future will depend on the balance between sea level rise, sediment loading, and potential tectonic subsidence or uplift.

The north lobe of San Francisco Bay is brackish and is known as San Pablo Bay. It is surrounded by Marin, Sonoma, Napa, and Solano counties. Suisun Marsh is between San Pablo Bay and the Delta and is the largest contiguous brackish marsh on the West Coast of North America, providing more than 10 percent of California's remaining natural wetlands. The south and central lobes of San Francisco Bay are saltier than San Pablo Bay, as the marine influence dominates.

Watersheds

The California Department of Water Resources (DWR) has grouped the watersheds in the Bay Region into seven hydrologic units, as shown in Figure SFB-2. The Suisun, San Pablo, and Bay bridges hydrologic units drain into Suisun, San Pablo, and North San Francisco bays, respectively. The South Bay and Santa Clara hydrologic units drain into South San Francisco Bay, and the Marin Coastal and San Mateo hydrologic units drain directly into the Pacific Ocean. Figure SFB-2 also shows 16 principal watersheds in the region. The Guadalupe River and Coyote and Alameda creeks drain from the Coast Ranges and generally flow northwest into San Francisco Bay. The Alameda Creek watershed is the largest in the region at 633 square miles. The Napa River originates in the Mayacamas Mountains at the northern end of Napa Valley and flows south into San Pablo Bay. Sonoma Creek begins in mountains within Sugarloaf State Park, then flows south through Sonoma Valley into San Pablo Bay.

PLACEHOLDER Figure SFB-2 Principal Watersheds in the San Francisco Bay Hydrologic Region

Surface Water Bodies

The most prominent surface water body in the Bay Region is San Francisco Bay itself. Other surface water bodies include:

- Creeks and rivers (see above)
- Ocean bays and lagoons (such as Bolinas Bay and Lagoon, Half Moon Bay, and Tomales Bay)
- Urban lakes (such as Lake Merced and Lake Merritt)
- Human-made lakes and reservoirs (such as Lafayette Reservoir, Briones Reservoir, Calaveras Reservoir, Crystal Springs Reservoir, Kent Lake, Lake Chabot, Lake Hennessey, Nicasio Reservoir, San Andreas Lake, San Antonio Reservoir, San Pablo Reservoir, Upper San Leandro Reservoir, and Lake Del Valle)

Groundwater Aquifers

Groundwater resources in the Bay Region are supplied by both alluvial and fractured-rock aquifers. Alluvial aquifers are composed of sand and gravel or finer grained sediments, with groundwater stored within the voids, or pore space, between the alluvial sediments. Fractured-rock aquifers consist of impermeable granitic, metamorphic, volcanic, or hard sedimentary rocks, with groundwater being stored within cracks, fractures, or other void spaces. The distribution and extent of alluvial and fractured-rock aquifers and water wells vary within the region. Municipal and irrigation wells in the region's aquifers range in depth from about 100 to 200 feet in the smaller basins, and 200 to 500 feet in the larger basins. Well yields typically are less than 500 gallons per minute in the smaller basins, and range from less than 50 to approximately 3,000 gpm in the larger basins. A brief description of the aquifers for the region is provided below.

Aquifer Description

Alluvial Aquifers

The Bay Region contains 33 Bulletin 118-2003-recognized alluvial groundwater basins and subbasins underlying approximately 1,400 square miles, or about 30 percent of the region (California Department of Water Resources 2003). The majority of the groundwater in the region is stored in alluvial aquifers. Figure SFB-3 shows the location of the alluvial groundwater basins and subbasins, and Table SFB-2 lists the associated names and numbers. The most heavily used groundwater basins in the region are — in North Bay, Petaluma Valley and Napa-Sonoma Valley groundwater basins; in South Bay, Santa Clara and San Mateo subbasins of the Santa Clara Valley Groundwater Basin and Westside Groundwater Basin; and in East Bay, Niles Cone and East Bay Plain Subbasin of the Santa Clara Valley Groundwater Basin and Livermore Valley Groundwater Basin.

PLACEHOLDER Figure SFB-3 Alluvial Groundwater Basins and Subbasins within the San Francisco Bay Hydrologic Region

PLACEHOLDER Table SFB-2 Alluvial Groundwater Basins and Subbasins within the San Francisco Bay Hydrologic Region

Petaluma Valley Groundwater Basin is contained within Sonoma County. Napa-Sonoma Valley Groundwater Basin is composed of three subbasins — Napa Valley, Sonoma Valley, and Napa-Sonoma Lowlands — and is spread over Sonoma, Napa and Solano counties. Both Petaluma Valley and Napa-Sonoma Valley basins consist of a relatively thin cover of Quaternary alluvium overlying a thick section of volcanic, sedimentary, sedimentary, metamorphic, and serpentinite rocks. The Quaternary alluvium consists of interbedded cobbles, sand, silt, and clay interlaced with coarse-grained stream channel deposits. The main freshwater-bearing geologic unit is the alluvium and the sedimentary rocks that range from 10 feet to more than 300 feet in thickness and yield more than 100 gpm in areas where deposits are thick and saturated (U.S. Geological Survey 2010, Scientific Investigations Report 2010-5089).

The Santa Clara Valley Groundwater Basin is spread over four countries — Contra Costa, Alameda, Santa Clara and San Mateo — and is composed of four subbasins — Niles Cone, Santa Clara, San Mateo Plain, and East Bay Plain. Niles Cone Subbasin is composed chiefly of alluvial fans consisting of unconsolidated gravels, sands, silts, and clays. The underlying aquifer is both unconfined and confined due to the presence of local low-permeable layers. A majority of the water-bearing materials are composed of Quaternary alluvium, though the Santa Clara formation underlies a portion of the groundwater basin along its eastern margin, which likely exceeds a thickness of 500 feet. Santa Clara and San Mateo Plain Subbasins are composed of two major water-bearing formations — quaternary alluvium overlying the Santa Clara Formation. Both formations consist of gravels, sands, silts and clays with various grain-size distributions. The northern portion of this area is confined and is overlain by a clay layer of low permeability. The southern portion is generally unconfined and contains no thick clay layers. East Bay Plain Subbasin consists of artificial fill overlying unconsolidated sediments. The cumulative thickness of the unconsolidated sediments is about 1,000 feet, and these extend beneath the San Francisco Bay to the west.

Livermore Valley Groundwater Basin is the largest alluvial groundwater basin east of the San Francisco Bay. The primary water-bearing formations include valley-fill materials, the Livermore Formation, and the Tassajara Formation, which consist of continental deposits from alluvial fans, outwash plains, and lakes. The surficial valley-fill materials exist up to 400 feet thick, while the Livermore Formation can be up to 4,000 feet thick, consisting of unconsolidated to semi-consolidated beds of gravels, sands, silts, and clays. Under most conditions, the valley-fill materials and the Livermore Formation sediments yield adequate to large quantities of groundwater. However, wells tapping the Tassajara Formation yield small quantities of water, and there is little hydrologic continuity between it and the overlying water-bearing units.

Fractured-Rock Aquifers

Fractured-rock aquifers are generally found in the mountain and foothill areas adjacent to alluvial groundwater basins. Due to the highly variable nature of the void spaces within fractured-rock aquifers, wells drawing from fractured-rock aquifers tend to have less capacity and less reliability than wells drawing from alluvial aquifers. On average, wells drawing from fractured-rock aquifers yield 10 gpm or less. Although fractured-rock aquifers are less productive compared to alluvial aquifers, they commonly serve as the sole source of water and a critically important water supply for many communities. The majority of the water used in the San Francisco Bay Hydrologic Region is derived either from alluvial aquifers or from imported water supplies; therefore, information related to fractured-rock aquifers in the region was not developed as part of the *California Water Plan Update 2013* (Update 2013).

More detailed information regarding the aquifers in the San Francisco Bay Hydrologic Region is available online in Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013 and DWR Bulletin 118-2003."

Well Infrastructure and Distribution

Well logs submitted to DWR for water supply wells completed during 1977 through 2010 were used to evaluate the distribution of water wells and the uses of groundwater in the San Francisco Bay Hydrologic Region. DWR does not have well logs for all the wells drilled in the region; and for some well logs, information regarding well location or use is inaccurate, incomplete, ambiguous, or missing. Hence, some well logs could not be used in the current assessment. However, for a regional scale evaluation of well installation and distribution, the quality of the data is considered adequate and informative. The number and distribution of wells in the region are grouped according to their location by county and according to six most common well-use types: domestic, irrigation, public supply, industrial, monitoring, and other. Public supply wells include all wells identified in the well completion report as municipal or public. Wells identified as "other" include a combination of the less common well types, such as stock wells, test wells, or unidentified wells (no information listed on the well log).

Nine counties were included in the analysis of well infrastructure for the San Francisco Bay Hydrologic Region. San Francisco County is fully contained within the region, while Napa, Marin, Alameda, Santa Clara, San Mateo, Sonoma, Solano, and Contra Costa counties are partially contained within the region. Well log data for counties that fall within multiple hydrologic regions were assigned to the hydrologic region containing the majority of alluvial groundwater basins within the county. Well log information listed in Table SFB-3 and illustrated in Figure SFB-4 show that the distribution and number of wells vary widely by county and by use. The total number of wells installed in the region between 1977 and 2010 is approximately 62,900, and ranges from a high of about 34,200 in Santa Clara County to less than 1,600 for San Francisco County. In most counties, monitoring wells make up the majority of well logs — 24,500 in Santa Clara County, followed by about 12,000 in Alameda County. The one exception is Napa County where over 60 percent of the wells are domestic wells. Communities with a high percentage of monitoring wells compared to other well types may indicate the presence of groundwater quality monitoring to help characterize groundwater quality issues.

PLACEHOLDER Table SFB-3 Number of Well Logs by County and Use for the San Francisco Bay Hydrologic Region

PLACEHOLDER Figure SFB-4 Number of Well Logs by County and Use for the San Francisco Bay

Figure SFB-5 shows that monitoring wells make up the majority of well logs (66 percent) for the region, while domestic and irrigation wells account for only about 14 percent and 4 percent of well logs, respectively. Although, domestic wells only make up about 14 percent of the total wells in the region, their absolute numbers range from 650 in Alameda County to a high of about 3,000 in both Napa and Santa Clara Counties.

PLACEHOLDER Figure SFB-5 Percentage of Well Logs by Use for the San Francisco Bay Hydrologic Region (1977-2010)

Figure SFB-6 shows a cyclic pattern of well installation for the region, with new well construction ranging from about 50 in 1978 to 4,500 in 1991, with an average of about 1,850 wells per year.

PLACEHOLDER Figure SFB-6 Number of Well Logs Filed per Year by Use for the San Francisco Bay Hydrologic Region (1977-2010)

The onset of monitoring well installation in the mid- to late-1980s is likely associated with federal underground storage tank programs signed into law in the mid-1980s. The installation of monitoring wells in the region peaked in 1990 at about 3,500 wells, with an average of about 3,200 monitoring wells installed per year from 1988 through 1992. Since 1993, monitoring well installation in the region has averaged approximately 950 wells per year.

As Figure SFB-6 shows, domestic well installation is somewhat related to hydrology and surface water availability. The number of domestic wells drilled during dry years (e.g., 1987-1992) is generally greater than during wet years when surface water is more readily available. The increase in number of domestic wells drilled in 2001-2003 is, however, attributed to the housing boom in California during that period.

More detailed information regarding assumptions and methods of reporting well log information is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

California Statewide Groundwater Elevation Monitoring (CASGEM) Basin Prioritization

The Legislature in 2009, as part of a larger package of water-related bills, passed Senate Bill 7x 6 (SBx7 6; Part 2.11 to Division 6 of the California Water Code § 10920 et seq.) requiring that groundwater elevation data be collected in a systematic manner on a statewide basis and be made readily and widely available to the public. DWR was charged with administering the program, which was later named the "California Statewide Groundwater Elevation Monitoring" or "CASGEM" Program. The new legislation requires DWR to identify the current extent of groundwater elevation monitoring within each of the alluvial groundwater basins defined under Bulletin 118-2003. The legislation also requires DWR to prioritize groundwater basins to help identify, evaluate, and determine the need for additional groundwater level monitoring by considering available data. Box SFB-1 provides a summary of these data considerations and resulting possible prioritization category of basins. *More detailed information on groundwater basin prioritization is available online from Update 2013, Volume 4, Reference Guide – California's Groundwater Update 2013.*

PLACEHOLDER Box SFB-1 California Statewide Groundwater Elevation Monitoring (CASGEM) Basin Prioritization Data Considerations

Figure SFB-7 shows the groundwater basin prioritization for the region. Of the 33 basins within the region, one basin was identified as high priority, six basins as medium priority, one as low priority, and the remaining 25 basins as very low priority; no basin was identified as very high priority. Table SFB-4 lists the high, medium, and low CASGEM priority groundwater basins for the region. The seven basins designated as high or medium priority account for more than 60 percent of the population and about 88 percent of groundwater supply in the region. The basin prioritization could be a valuable tool to help evaluate, focus, and align limited resources for effective groundwater management, and reliability and sustainability of groundwater resources.

PLACEHOLDER Figure SFB-7 CASGEM Groundwater Basin Prioritization for the San Francisco Bay Hydrologic Region

PLACEHOLDER Table SFB-4 CASGEM Groundwater Basins Prioritization for the San Francisco Bay Hydrologic Region

San Francisco Bay Hydrologic Region Groundwater Monitoring Efforts

Groundwater resource monitoring and evaluation is a key aspect to understanding groundwater conditions, identifying effective resource management strategies, and implementing sustainable resource management practices. California Water Code (§10753.7) requires local agencies seeking State funds administered by DWR to prepare and implement groundwater management plans that include monitoring of groundwater levels, groundwater quality degradation, inelastic land subsidence, and changes in surface water flow and quality that directly affect groundwater levels or quality. This section summarizes some of the groundwater level, groundwater quality, and land subsidence monitoring efforts within the San Francisco Bay Hydrologic Region. Groundwater level monitoring well information includes only active monitoring wells — those wells that have been measured since January 1, 2010. *Additional information* *regarding the methods, assumptions, and data availability associated with the groundwater monitoring is available online from Update 2013, Volume 4, Reference Guide , the article "California's Groundwater Update 2013."*

Groundwater Level Monitoring

A list of the number of monitoring wells in the region by monitoring agencies, cooperators, and CASGEM monitoring entities is provided in Table SFB-5. The locations of these monitoring wells by monitoring entity and monitoring well type are shown in Figure SFB-8. Table SFB-5 shows that a total of 116 wells in the region have been actively monitored for groundwater levels since 2010. The U.S. Geological Survey (USGS) monitors six wells; one cooperator and seven designated CASGEM monitoring entities monitor the remaining 110 wells. A comparison of Figure SFB-7 discussed previously and Figure SFB-8 indicates that several basins identified as having a high to medium priority under the CASGEM groundwater basin prioritization are being monitored for groundwater levels.

PLACEHOLDER Table SFB-5 Groundwater Level Monitoring Wells by Monitoring Entity in the San Francisco Bay Hydrologic Region

PLACEHOLDER Figure SFB-8 Monitoring Well Location by Agency, Monitoring Cooperator, and CASGEM Monitoring Entity in the San Francisco Bay Hydrologic Region

The groundwater level monitoring wells are categorized by the type of well use and include domestic, irrigation, observation, public supply, and other. Groundwater level monitoring wells identified as "other" include a combination of the less common well types, such as stock wells, test wells, or unidentified wells (no information listed on the well log). Wells listed as "observation" also include those wells described by drillers in the well logs as "monitoring" wells. Domestic wells are typically relatively shallow and are in the upper portion of the aquifer system, while irrigation wells tend to be deeper and are in the middle-to-deeper portion of the aquifer system. Some observation wells are constructed as a nested or clustered set of dedicated monitoring wells, designed to characterize groundwater conditions at specific and discrete production intervals throughout the aquifer system. Figure SFB-9 shows that wells identified as observation and other account for 48 and 25 percent, respectively, of the monitoring wells in the region while wells listed as domestic comprise 20 percent of the total; irrigation and public supply wells comprise less than 7 and 1 percent of the total, respectively.

PLACEHOLDER Figure SFB-9 Percentage of Monitoring Wells by Use in the San Francisco Bay Hydrologic Region

Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect to effective groundwater basin management and is one of the components that are required to be included in groundwater management planning in order for local agencies to be eligible for State funds. Numerous State, federal, and local agencies participate in groundwater quality monitoring efforts throughout California. A number of the existing groundwater quality monitoring efforts were initiated as part of the Groundwater Quality Monitoring Act of 2001, which implemented goals to improve and increase the statewide availability of groundwater quality data. A summary of the larger groundwater quality monitoring efforts and references for additional information are provided below.

Regional and statewide groundwater quality monitoring information and data are available on the State Water Resources Control Board (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) Web site and the GeoTracker GAMA groundwater information system developed as part of the Groundwater Quality Monitoring Act of 2001. The GAMA Web site describes GAMA program and provides links to all published GAMA and related reports. The GeoTracker GAMA groundwater information system geographically displays information and includes analytical tools and reporting features to assess groundwater quality. This system currently includes groundwater data from the SWRCB, Regional Water Quality Control Boards (RWQCBs), California Department of Public Health (CDPH), Department of Pesticide Regulation (DPR), DWR, USGS, and Lawrence Livermore National Laboratory (LLNL). In addition to groundwater quality data, GeoTracker GAMA has more than 2.5 million depth-to-groundwater measurements from the Water Boards and DWR, and also has oil and gas hydraulically fractured well information from the California Division of Oil, Gas, and Geothermal Resources. Table SFB-6 provides agency-specific groundwater quality information. Additional information regarding assessment and reporting of groundwater quality information is furnished later in this report.

PLACEHOLDER Table SFB-6 Sources of Groundwater Quality Information

Land Subsidence Monitoring

Land subsidence has been shown to occur in areas experiencing significant declines in groundwater levels. In the San Francisco Bay Hydrologic Region, land subsidence is monitored in Santa Clara County by Santa Clara Valley Water District (SCVWD) and in Alameda County by East Bay Municipal Utilities District (EBMUD). SCVWD surveys hundreds of benchmarks each year to determine changes in the land surface elevation, monitors groundwater levels, and collects data from two 1,000-foot deep compaction wells designed to measure any changes in the land surface resulting from groundwater extraction (http://www.valleywater.org/Services/LandSubsidence.aspx). SCVWD also conducts numerical modeling to monitor subsidence in the area. EBMUD monitors land subsidence in the South East Bay Plain as part of its Bayside Groundwater Project (East Bay Municipal Utilities District 2013).

Ecosystems

Two-thirds of the state’s salmon pass through San Francisco Bay and the Delta each year, as do approximately half of the waterfowl and shorebirds migrating along the Pacific Flyway (San Francisco Regional Water Quality Control Board 2004). However, the San Francisco Bay is one of the most modified estuaries in the United States. The topography, ebb and flow tides, local freshwater and Delta inflows, and sediment availability all have been altered. Many new species of plants and animals have been introduced. These exotic and invasive species, such as the Chinese Mitten Crab and the Asian Clam, threaten to undermine the estuary’s food web and ecosystem. Approximately 500 species of fish and wildlife live in the Bay Region, of which 105 wildlife species are designated by State and federal agencies as threatened or endangered.

The land between the lowest tide elevations and mean sea level are tidal flats, which support an extensive community of invertebrate aquatic organisms, fish, plants and shorebirds. Historically; around 50,000 acres of tidal flats were situated around San Francisco Bay margins; but only about 29,000 acres remain.

Before 1800, the total area covered by the bay at high tide was about 516,000 acres, and another 190,000 acres on the fringe of the bay were wetlands. Today the bay covers about 327,000 acres at high tide, and only 40,000 acres of wetlands border the bay. Almost 80 percent of the bay's historical wetlands have been lost or altered through a variety of land use changes, such as filling the bay for urban and industrial developments, and building dikes for agricultural purposes. Filling the bay has slowed significantly due to regulatory changes and the creation of the Bay Conservation and Development Commission (BCDC) in 1965, a State agency charged with permitting activities along the shore of the bay.

Channelizing and rerouting Bay Region streams for flood control has degraded or denuded riparian areas, with significant adverse impacts to aquatic and riparian habitats. Coastal streams may have an excess of fine sediments and a lack of spawning gravels and large woody debris. Excess sediment also threatens water quality and habitat in Bolinas Lagoon, the only wetland on the West Coast that the U.S. Fish and Wildlife Service (USFWS) has designated as a Wetland of International Significance.

The Baylands Ecosystem Habitat Goals Project, a major multi-partner, multi-disciplinary project completed in the late 1990s, developed recommendations for distributing wetlands in the Bay Region, and was a catalyst for undertaking significant wetland restoration in the region. The project now is incorporating climate change adaptation into wetland restoration recommendations. The San Francisco Regional Water Quality Control Board (SFRWQCB) provides technical input and permitting for thousands of acres of wetland and riparian restoration projects around San Francisco Bay.

Flood

The Bay Region generally receives very little snow so floodwaters originate primarily from intense rainstorms. Flooding occurs more frequently in winter and spring and can be intense for a short duration in small watersheds with steep terrain. Urban areas can flood when storm drains and small channels become blocked or surcharged during intense short-duration storms. Valley flooding tends to occur when large, widespread storms fall on previously saturated watersheds that drain into the valley. The greatest flood damages occur in the lower reaches of streams when floodwaters spill onto the floodplain and spread through urban neighborhoods. Hillsides denuded by wildfires can exacerbate flood damages by intercepting less rainfall and generating more runoff containing massive sediment loads. Storm surges coincident with high tides can create severe flooding in low-lying areas by the mouths of rivers. The Bay Region is a complex of local watersheds and receiving embayment from the Central Valley runoff of snowmelt and rain storms. In general, these watersheds are developed urban valleys or bayside alluvial plains and less-developed uplands areas. The region is characterized by flooding events when large widespread storms follow several days of rainfall. Flooding occurs locally when flood facilities and natural drainages' capacities are exceeded. In low-lying areas near the bay, including the Carquinez Strait and portions of the Delta, flooding may be exacerbated by high tides and storm surges that back up the natural riverine flows or flood channels. Thus, flooding in this region is marked by a complex and diverse range of the nature and character of storms, river flows, sea level, and topography. Added to this mix are the diverse development patterns from range lands, orchards and field crops, coastal and rural development, dense urban, suburban and hillside development affecting local runoff. Geology, soils, and topography are important aspects of flood events. Climate change-induced sea level rise is creating a new flood hazard from extreme tides on higher sea levels. (See Box SFB-2 New Feature — Near Coastal.)

PLACEHOLDER Box SFB-2 New Feature — Near-Coastal

Climate

Like most of Northern California, the climate in the Bay Region largely is governed by weather patterns originating in the Pacific Ocean. The southern descent of the Polar Jet Stream brings mid-latitude cyclonic storms in the winter. About 90 percent of the annual precipitation falls between November and April. The North Bay receives about 20 to 25 inches of precipitation annually. In the South Bay, east of the Santa Cruz Mountains, annual precipitation is only about 15 to 20 inches because of the rain shadow effect. Historical precipitation in San Francisco since 1914 ranges from 9 to 44 inches annually, with an average of 21 inches.

The varied topography of the region creates several microclimates. Large climatic differences can occur over only a few miles. Some higher elevations in the region, particularly along west-facing slopes, average more than 40 inches of precipitation annually. The precipitation in the higher elevations typically falls as rain since the elevations are not high enough to sustain a snowpack.

Temperatures in the Bay Region generally are cool, and fog often resides along the coast. The inland valleys receive warmer, Mediterranean-like weather. Average summer high temperatures are about 80 °F, nearly 10 degrees higher than in San Francisco, resulting in higher outdoor water use. The gap in the rolling hills at Carquinez Strait allows cool air to flow from the Pacific Ocean into the Sacramento Valley. Most of the interior North Bay and the northern parts of the South Bay are influenced by this marine effect. By contrast, the southern interior portions of the South Bay experience very little marine air movement.

Demographics

Population

The San Francisco Bay Hydrologic Region had a population of 6,345,194 people in the 2010 census, making it second only to the South Coast Hydrologic Region in population out of the 10 California hydrologic regions. About 17 percent of Californians live in the Bay Region, and 92 percent of the region lives in 101 incorporated cities. The three largest cities are San Francisco, San Jose, and Oakland. The region had a growth rate of 2.96 percent between 2006 and 2010 (187,991 people). Nine projections of population growth and 13 scenarios of future climate change can be found in the Looking to the Future chapter to estimate the urban and agricultural changes in water demand in the Bay Region from 2006 to 2050.

Tribal Communities

The Bay Region historically had six tribal groups — the Coast Miwok, Sierra Miwok, Ohlone/Coastanoan, Northern Valley Yokuts, Patwin (Southern Wintu), and Wappo, but they did not survive conflict and disease from Spanish contact and then the Gold Rush settlers and miners. Descendants of these tribes still have historical or cultural ties to the Bay Region. Only one tribal community currently owns land in the region — the Lytton Band of Pomo Indians. They own and operate the San Pablo Lytton Casino in the East Bay. Individual members of other tribes are dispersed throughout the region.

The federal government does not recognize any tribes in the Bay Region, however the Muwekma Ohlone Indian Tribe of the San Francisco Bay and the Mishewal Wappo Tribe of Alexander Valley are seeking recognition. California government code §65352.3 requires cities and counties to consult with tribes during the adoption or amendment of local general plans or specific plans. A contact list of tribes and their representatives is maintained by the Native American Heritage Commission. Also, a Tribal Consultation Guideline, prepared by the Governor's Office of Planning and Research, is available online at http://opr.ca.gov/docs/09_14_05_Updated_Guidelines_922.pdf

Disadvantaged Communities

DWR defines disadvantaged communities (DACs) as communities with an annual median household income (MHI) less than 80 percent of the statewide average (less than $48,706). The water agencies and nonprofit organizations working on the Bay Area Integrated Regional Water Management Plan (IRWMP) have established a high priority for the water needs of low-income DACs. The required non-State cost share can be waived for grant-funded DAC projects. DAC projects include both construction projects and studies that identify critical water supply or water quality needs. Example projects include:

- Management of flood flows that threaten the habitability of dwellings.
- Wastewater treatment necessary to abate or prevent surface water or groundwater contamination.
- Replacement of failing septic systems with a system that provides long-term wastewater treatment.

Nine of the 23 Bay Area Regional Priority Projects (see State Funding Received) address the critical water quality needs of DACs throughout the Bay Region. These DACs include North Richmond; the City of San Pablo; the City of East Palo Alto; Bay Point; the Town of Pescadero; and Title I disadvantaged schools in Solano, Napa, Sonoma and Marin counties. These communities are concerned about the lack of stormwater management, flood damages, and water quality impacts from flooding. Some flooded areas contain toxic sites such as power plants, weapons facilities, and chemical plants, which exacerbate the water quality and human health risks of flooding. These communities also are vulnerable to the impacts of sea level rise because of their proximity to the fringe of the bay.

Land Use Patterns

Land use in the Bay Region is truly diverse. The region is home to the world-famous Napa Valley and Sonoma County wine-growing industries, to international business and tourism in San Francisco, to technological development and production in the "Silicon Valley," and to agriculture.

Agriculture uses 21 percent of the Bay Region's land area, most of which is in the north and northeast bay in Napa, Marin, Sonoma, and Solano Counties. Santa Clara and Alameda counties also have significant agricultural acreage at the edge of urban development. The predominant crops are wine grapes (72 percent), fruit and nut trees, and hay production. Along the coastline south of the City of San Francisco, half of the irrigated land includes specialty crops such as artichokes, strawberries, and flowers.

Federal land in the Bay Region includes Point Reyes Seashore, John Muir Wood Monument and John Muir Historic Site, Golden Gate Recreation Area, Alcatraz Island, Fort Point Historic Site, Presidio of San Francisco, San Francisco Maritime Historic Park, Eugene O'Neill Historic Site, Rosie the Riveter WWII Home Front Park, and Port Chicago Naval Magazine Memorial.

Bay Region cities and counties typically have primary authority over land use decisions; while special districts, flood control agencies, investor-owned utilities, and mutual water companies typically manage water resources. Integrating land use and water resources decision-making is essential to meet existing and future resource management challenges. Residents live in urban, suburban, and rural areas. Some of these areas are on natural floodplains, which historically were used for agriculture. Now many residents are in the 100-year floodplain, as shown in Federal Emergency Management Agency (FEMA) maps. Growth in 100-year floodplains is being discouraged by limiting infill development through zoning restrictions and building regulations.

Such integration includes implementing Low-Impact Development features to manage stormwater runoff and reduce flooding, assessing water supplies to determine if planned developments will have sufficient water, modifying local land use to reduce per capita water consumption, and implementing best management practices to prevent construction pollutants from contacting stormwater. Additional integration includes implementing urban and agricultural erosion control measures, agricultural fertilizer and waste management measures, urban runoff management measures, and riparian buffers and setbacks.

Regional Resource Management Conditions

Water in the Environment

Water is regulated in the Bay Region to support the environment for purposes such as ecosystem health, fisheries, riparian habitat, and wetlands. Several local governments and conservation groups have initiatives to improve fish passage and to re-establish wetlands and habitat for fish, birds, and other wildlife. The most important habitats near the shore of San Francisco Bay are deep and shallow bays and channels, tidal baylands, and diked baylands. Tidal baylands include tidal flats, salt and brackish marshes, and lagoons. Diked baylands include diked wetlands, agricultural lowlands, salt ponds, and storage ponds.

The San Francisco Bay Joint Venture (SFBJV); established under The Migratory Bird Treaty Act and funded by the Interior Appropriations Act; was created to protect, restore, increase, and enhance all types of wetlands, riparian habitats, and associated uplands throughout the Bay Region to benefit birds, fish, and other wildlife. In 2001, SFBJV published a 20-year collaborative plan for the restoration of wetlands and wildlife in the Bay Region called "Restoring the Estuary: an Implementation Strategy." This strategy laid out programmatic and cooperative strategies for accomplishing specific acreage increase goals for wetlands of three distinct types — bay habitats, seasonal wetlands, and creeks and lakes. SFBJV partners have agreed to acquire, restore, or enhance 260,000 acres of wetlands over the next two decades throughout the estuary (see San Francisco Bay Joint Venture Web site, http://www.sfbayjv.org/).

SWRCB licenses and other agreements with regulatory agencies require adequate in-stream flows to be provided below most major dams and diversions to promote the health of endangered coho salmon (*Oncorhynchus Kisutch*), steelhead trout, and other fisheries. Coho salmon populate coastal watersheds from the Oregon border to northern Monterey Bay. The California Department of Fish and Wildlife (DFW), with the assistance of recovery teams representing diverse interests and perspectives, created "Recovery Strategy for California Coho Salmon" (2004) to outline the process of recovering coho salmon along the north and central coasts of California. The recovery strategy emphasizes cooperation and collaboration, recognizes the need for funding and public and private support, and maintains a balance between regulatory and voluntary efforts. Landowner incentives and grant programs are some of the many tools available to recover coho salmon. The success of the recovery strategy depends on the long-term commitment and efforts of all who live in, or are involved with, coho salmon watersheds.

The Ecosystem Restoration Program (ERP) conservation strategy for the Delta and the Suisun Marsh Planning Area provides leadership for conservation and restoration. It was developed by DFW in collaboration with USFWS and National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries). The conservation strategy is intended to facilitate coordination and integration of all resource planning, conservation, and management decisions affecting the Delta and Suisun Marsh. It is integrally linked to the Delta Vision and the conceptual models developed under the Adaptive Management Planning Team, and takes into account sea level rise projections and the effects of potential seismic events. *Environmental restoration in the Delta is discussed more in the regional report Sacramento-San Joaquin Delta, of Volume 2 of Update 2013.*

Water Supplies

High-quality, reliable water supplies are critical to the Bay Region's economic prosperity and development. Bay Region water agencies seek to protect the quality and reliability of existing supplies through innovative water management strategies and regional cooperation. These agencies manage a diverse portfolio of water supplies, including groundwater, local surface water, Sierra Nevada water from the Mokelumne and Tuolumne rivers, Delta water from the SWP and the CVP, and recycled water. San Francisco Public Utilities Commission (SFPUC), EBMUD, and SCVWD have critical water interties to deliver water between water systems during emergencies such as earthquakes and wildfires.

SWP contractors and DWR established the Monterey Agreement in 1994 to improve water management flexibility and increase the reliability of SWP deliveries during periods of water shortage. Further details about the Monterey Agreement can be found in DWR Bulletin 132-95 at http://www.dwr.water.ca.gov/swpao/bulletin.cfm.

For an overview of the San Francisco Bay's water flows, see Figure SFB-10.

PLACEHOLDER Figure SFB-10 San Francisco Bay Regional Inflows and Outflows

Surface Water

EBMUD and SFPUC import surface water into the Bay Region from the Mokelumne and Tuolumne rivers via the Mokelumne and Hetch Hetchy aqueducts, respectively. Additional deliveries are made from the SWP's South Bay Aqueduct (SBA) and North Bay Aqueduct (NBA); the CVP's Contra Costa Canal, Putah South Canal, and San Felipe Unit; and Sonoma County Water Agency's (SCWA) Sonoma and Petaluma aqueducts. Reservoirs in the region capture runoff to augment local water supplies and to recharge aquifers. Some reservoirs store water at the terminus of constructed aqueducts, such as the Santa Clara Terminal Reservoir at the terminus of the SBA. Today, about 70 percent of the urban water supply is imported into the Bay Region. Table SFB-7 shows the sources of imported water, the conveyance facilities, and the volume of water that each facility delivered in 2010. Many Bay Region residents get their water from local streams. In the South Bay, local streams supply water to the San Francisco Water Department, the City of San Jose, cities in Alameda County, and to small developments in the surrounding mountains. The Alameda County Water District (ACWD) and Zone 7 Water Agency (Zone 7) recharge their groundwater basins with local streams, as well as with deliveries from the SWP.

PLACEHOLDER Table SFB-7 Sources of Imported Surface Water, San Francisco Bay Hydrologic Region

Local streams also play a large role in the North Bay, providing a majority of the water supply for Marin and Napa counties. Built in 1979, Soulajule Reservoir on Walker Creek is the newest of the seven Marin Municipal Water District (MMWD) reservoirs and provides 10,572 acre-feet (af) of storage — about 13 percent of its total reservoir capacity. Lake Hennessey on Conn Creek provides 31,000 af of storage. A 30-mile pipeline from the lake to the City of Napa provides the city with its primary source of water.

Groundwater

The amount and timing of groundwater extraction, along with the location and type of its use, are fundamental components for building a groundwater basin budget and identifying effective options for groundwater management. Although some types of groundwater extractions are reported for some California basins, the majority of groundwater pumpers are not required to monitor, meter, or publicly record their annual groundwater extraction amounts.

Groundwater supply estimates furnished herein are based on water supply and balance information derived from DWR land use surveys, and from groundwater supply information voluntarily provided to DWR by water purveyors or other State agencies.

Groundwater supply is reported by water year (October 1 through September 30) and categorized according to agriculture, urban, and managed wetland uses. The associated information is presented by planning area, county, and by the type of use. Reference to total water supply represents the sum of surface water and groundwater supplies in the region, and local reuse.

2005-2010 Average Annual Groundwater Supply and Trend

Although much of the water use in the region is met by imported water from Sierra Nevada and Sacramento-San Joaquin River Delta sources through various federal, State, and local projects, groundwater remains a mainstay of the overall water supply and a critical component of the water supplies for agencies in the region to offset the variability of imported water.

Table SFB-8 provides the 2005-2010 average annual groundwater supply by planning area and by type of use, while Figure SFB-11 depicts the planning area locations and the associated 2005-2010 groundwater supply in the region. The estimated average annual 2005-2010 total water supply for the region is about 1.2 million acre-feet. Out of the 1.2 maf total supply, groundwater supply is 260 thousand acre-feet (taf) and represents about 20 percent of the region's total water supply; 16 percent (184 taf) of the overall urban water use and 74 percent (76 taf) of the overall agricultural water use being met by groundwater. No groundwater resources are used for meeting managed wetland uses in the region. Although statewide, groundwater extraction in the region accounts for only about 2 percent of California's 2005-2010 average annual groundwater supply, it accounts for 100 percent of the supply for some local communities and is used significantly to help facilitate local conjunctive water management in the region.

PLACEHOLDER Table SFB-8 San Francisco Bay Hydrologic Region Average Annual Groundwater Supply by Planning Area and by Type of Use (2005-2010)

PLACEHOLDER Figure SFB-11 Contribution of Groundwater to the San Francisco Bay Hydrologic Water Supply by Planning Area (2005-2010)

Regional totals for groundwater based on county area will vary from the planning area estimates shown in Table SFB-8 because county boundaries do not necessarily align with planning area or hydrologic region boundaries. San Francisco County is fully contained within the San Francisco Bay Hydrologic Region, while Napa, Marin, Alameda, Santa Clara, San Mateo, Sonoma, Solano, and Contra Costa counties are partially contained within the region. Groundwater supply for Sonoma, Solano and Contra Costa counties are reported in the North Coast, Sacramento River, and San Joaquin River hydrologic regions, respectively. For the San Francisco Bay Hydrologic Region, county groundwater supply is reported for Napa, Marin, Alameda, San Francisco, Santa Clara and San Mateo counties (Table SFB-9). Overall, groundwater contributes to 26 percent of the total water supply for the six-county area; the range varies from close to zero percent for San Francisco County to 59 percent for Napa County. Groundwater supplies in the six-county area are used to meet about 60 percent of the agricultural water use and 21 percent of the urban water use.

PLACEHOLDER Table SFB-9 San Francisco Bay Hydrologic Region Average Annual Groundwater Supply by County and by Type of Use (2005-2010)

As shown in Table SFB-8 and Figure SFB-11, South Bay Planning Area is the larger user of groundwater in the region with an average annual groundwater supply equal to 181 taf (70 percent of the total groundwater supply for the region). Although the South Bay relies on groundwater supplies for only 18 percent of its overall water uses, 85 percent of the agricultural water use in the South Bay is met by groundwater. North Bay Planning Area provides an average annual groundwater supply equal to 79 taf, providing 34 percent of the overall water supply and meeting 71 percent of the agricultural water use in the planning area.

More detailed information regarding groundwater water supply and use analysis is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

Changes in annual groundwater supply and type of use may be related to a number of factors, such as changes in surface water availability, urban ad agricultural growth, market fluctuations, and water use efficiency practices.

Figures SFB-12 and SFB-13 summarize the 2002 through 2010 groundwater supply trends for the region. The right side of Figure SFB-12 illustrates the annual amount of groundwater versus other water supply, while the left side identifies the percent of the overall water supply provided by groundwater relative to other water supply. The center column in the figure identifies the water year along with the corresponding amount of precipitation, as a percentage of the 30-year running average for the region. Figure SFB-13 shows the annual amount and percentage of groundwater supply trends for meeting urban, agricultural, and managed wetland uses.

PLACEHOLDER Figure SFB-12 San Francisco Bay Hydrologic Region Annual Groundwater Water Supply Trend (2002-2010)

PLACEHOLDER Figure SFB-13 San Francisco Bay Hydrologic Region Annual Groundwater Supply Trend by Type of Use (2002-2010)

Figure SFB-12 shows that between 2002 and 2010, the annual water supply for the region has fluctuated between approximately 1,380 taf in 2002 and 1,100 taf in 2010. During the same period, the annual groundwater supply has fluctuated between approximately 280 taf in 2008 to 240 taf in 2010, and provided between 18 and 23 percent of the total water supply for the region. Figure SFB-13 indicates that groundwater supply meeting urban use ranged from 60 to 85 percent of the annual groundwater extraction, while groundwater extraction meeting agricultural use ranged from 20 to 35 percent. Groundwater was not used for meeting any managed wetland use.

Recycled Water

Recycled water is used for many applications in the Bay Region, including agriculture, landscape irrigation, commercial and industrial purposes, and wetland replenishment. The region has a large potential market for recycled water — up to 240,000 acre-feet per year by 2025 as reported in the 1999 Bay Area Recycled Water Master Plan. The latest SFRWQCB report states that 58,000 af of water is recycled per year of the approximately 600,000 acre-feet of wastewater generated in the region per year.

The Bay Region has a long history of regional recycled water planning. Following years of drought in the early 1990s, and facing uncertain future water supplies, the Bay Area Clean Water Agencies (BACWA) formed a partnership with the U.S. Bureau of Reclamation (USBR) and DWR to study the feasibility of a regional approach to water recycling. The study produced the Bay Area Regional Water Recycling Program, which is the foundation of regional recycled water planning throughout the Bay Region.

The IRWM planning process has created partnerships among Bay Region agencies to further develop recycled water projects. The San Francisco Bay Area IRWMP and East Contra Costa County (ECCC) IRWMP identify several proposed recycled water projects. Collaboration between the Bay Area and the ECCC IRWM groups intends to develop joint recycled water projects.

Through IRWM, the Bay Area Regional Water Recycling Program Authorization Act was enacted in 2008. This act enabled USBR to fund eight recycled water projects under Title 16. The act also enabled the SCVWD to receive federal stimulus money for two recycled water projects. One project is to improve the South Bay Advanced Recycled Water Treatment Facility, a joint effort between SCVWD and the City of San Jose to treat wastewater byproducts. The other project is to develop short- and long-term content for SCVWD’s South County Recycled Water Master Plan. Two additional recycled water treatment facilities were dedicated recently — Las Gallinas Valley Sanitary District’s facility on September 25, 2012, in San Rafael; and Novato Sanitary District’s facility on October 11, 2012, in Novato.

Desalinated Water

In 2003, the ACWD dedicated the first brackish water desalination facility in Northern California and expanded it in 2010 to double its production capacity to 10 million gallons per day (mgd). The Newark Desalination Facility receives its water from the Niles Cone Groundwater Basin, which contains some brackish water due to previous years of seawater intrusion. This was made possible as a result of ACWD Aquifer Reclamation Program (ARP), which has been working to eliminate seawater intrusion from the Niles Cone Groundwater Basin. Since the facility was completed, ACWD has reported improved water quality and production capacity, reduced reliance on imported supplies, and greater dry year supply reliability.

Another desalination project headed by the Contra Costa Water District (CCWD), EBMUD, SFPUC, and SCVWD has been considered since 2003. In 2010, Zone 7 joined this group. Their research led them to believe a facility could be built at CCWD Mallard Slough Pump Station. In order for it to be viable and reasonable, the group agreed that a 10 to 20 mgd facility would be best. As of 2013, this project is in the planning phase, but progress is being made in the form of studies and simulations.

MMWD is processing a desalination project off the coast of San Rafael. A recent decision by a Court of Appeal upheld the environmental document. Voter approval is needed for financing the planning, design, and permitting. As of 2013, there are no plans to move forward, although this could change depending on other sources of water.

Water Uses

Drinking Water

The SFRWQCB works with local water and sanitary districts to reduce the need for water imports by promoting the recycling of wastewater and the collection of stormwater in cisterns, groundwater basins, and local retention basins for safe uses in the Bay Region.

The region has an estimated 190 community drinking water systems (Table SFB-10). Over 60 percent are small systems serving fewer than 3,300 people with most of them serving fewer than 500 people. Small water systems face unique financial and operational challenges to provide safe drinking water. With a small customer base, many small water systems cannot develop or access the technical, managerial, and financial resources that they need to comply with new and existing regulations. These water systems may be geographically isolated; and their staff often lacks the time or expertise to make needed infrastructure repairs; install or operate treatment facilities; and develop comprehensive source water protection plans, financial plans, or asset management plans (U.S. Environmental Protection Agency 2012).

PLACEHOLDER Table SFB-10 Community Drinking Water Systems, San Francisco Bay Hydrologic Region

Medium and large community drinking water systems account for less than 40 percent of the region’s systems, but deliver drinking water to over 95 percent of the region’s population. These water systems generally have financial resources to hire staff that oversees daily operations and maintenance and that plans for future infrastructure replacement and capital improvements to help ensure that existing and future drinking water standards are met.

Municipal Use

About 70 percent of the urban water supply in the Bay Region is imported, and is relatively expensive due to the capital, operation, and maintenance costs of the projects that deliver the water. The high water rates, cool climate, small lot sizes, and high-density developments contribute to relatively low per capita urban water use. The City of San Francisco has a per capita use of around 100 gallons per day (gpd); ACWD, 160 gpd; and MMWD, 145 gpd. In contrast, water use for communities in the warmer Central Valley regions can range from 200 to 300 gpd, most of which is applied to residential landscapes.

Droughts, climate change, and population growth all could negatively impact the reliability of available water supplies. Local governments have started to require water efficient devices in new construction; and both local governments and water agencies have rebate programs to replace older, less efficient devices such as washing machines and toilets. Some agencies are offering between $0.25 and $1.00 per square foot to remove lawn area. Most water agencies have conservation tips and rebate information on their Web sites., and other Web sites such as www.saveourh2o.org/, and www.h2ouse.org promote water conservation.

Metering water use allows water purveyors to establish tiered rates, which provide customers an incentive to minimize use and avoid the higher tiers. Purveyors also provide public education on water conservation to encourage low water use. Much of the Bay Region is well-developed and is undergoing urban renewal. The older areas of Oakland and San Francisco are being replaced by new construction, which puts into service more water efficient devices.

Industrial Use

Industrial water use varies greatly throughout the Bay Region from as little as 1 percent by SFPUC to as much as 29 percent by CCWD. Despite an increasing population, the region has seen little change in total industrial water use and a reduction in total industry per capita water use over time. Currently, the Delta Diablo Sanitation District provides 8600 acre-feet per year of recycled water to power plants and is looking to supply an additional 12 mgd of recycled water to the Mirant Power Plant. The city of Benicia is undertaking another large industrial project with the Valero Refining Company to supply up to 2 mgd of high purity recycled water to Valero’s Benicia refinery for use as cooling tower make-up water. This project would reduce Valero’s demand for water from 4,480 to 5600 af per year to as little as 2,240 af per year.

Water Conservation Act of 2009 (SB x7-7) Implementation Status and Issues

Forty-four Bay Region urban water suppliers submitted 2010 urban water management plans to DWR. The urban water management plans include calculations of baseline water use, and set 2015 and 2020 water use targets, as required by the Water Conservation Law of 2009 (SBx7-7). The population-weighted baseline water use in the region is 153 gallons per capita per day, with a 2020 target of 133 gallons per capita per day. Baseline and target data for urban water suppliers in the region are available on DWR’s Urban Water Use Efficiency Web site at www.water.ca.gov/wateruseefficiency.

SBx7-7 also required agricultural water suppliers which serve more than 25,000 irrigated acres to prepare and adopt agricultural water management plans by December 31, 2012; and update those plans by December 31, 2015 and every 5 years thereafter. The Bay Region does not have any agricultural water suppliers that serve more than 25,000 acres; so none of them submitted an agricultural water management plan.

Water Balance Summary

The Bay Region consists of two planning areas, which are separated by the natural waterways of the Delta. The North Bay Area (PA 201) lies north of the confluence of the Sacramento and San Joaquin rivers, Suisun Bay, San Pablo Bay, and Golden Gate. The urban applied water ranges between 145 and 160 taf, about two-thirds of which is residential and the remainder commercial and industrial uses. Agricultural applied water averages about 92 taf, depending on the amount of rainfall in a particular year.

There are three rivers with instream flow requirements in PA 201 — Lagunitas Creek, Milliken Creek, and the San Joaquin River. The instream flows range from 0.4 to 1.5 maf. There are a few managed wetlands using about 1 taf per year. Brackish water that supplies the Suisun Marsh is not accounted for in the Water Balances as this supply is not a freshwater source of supply.

The instream supplies for PA 201 come from local rivers (primarily the San Joaquin River). Much of the urban supply comes from SWP (30-40 taf), federal deliveries (31-38 taf), or are locally imported (20-33 taf). Some groundwater is also extracted (75-100 taf), probably for agricultural use.

The South Bay Planning Area (PA 202) is primarily urban. Urban applied water ranges from about 0.9 to 1.0 maf, with about 60 percent being used for residential interior and exterior and the remainder commercial and industrial. From 60 to 115 taf of urban applied water are recharged into the groundwater basin. Agriculture uses about 20 to 25 taf in the planning area.

Environmental water use consists of about 3 taf annually applied to managed wetlands. There are no instream or wild and scenic requirements in PA 202.

Water supply comes from a variety of sources — locally (90-190 taf), locally imported (420-470 taf), CVP (90-176 taf), SWP (65-160 taf), groundwater (170-180 taf, most or all of which is offset by intentional recharge), reuse (3-25 taf), recycle (27-35 taf), and desalination (1.4 taf annually). Figure SFB-14 and Table SFB-11 shows the Bay Region's water balance for 2001-2010.

PLACEHOLDER Figure SFB-14 San Francisco Bay Hydrologic Region Water Balance by Water Year, 2001-2010

PLACEHOLDER Table SFB-11 San Francisco Bay Hydrologic Region Water Balance Summary for 2001-2010 (thousand acre-feet)

Project Operations

State, federal, and local conveyance systems deliver water to the Bay Region, as described in the Water Supplies section. The water is stored in over 30 reservoirs throughout the region. This section lists some of the larger reservoirs and their capacities, and discusses ongoing seismic retrofits to dams that impound some of the reservoirs.

East Bay Reservoirs

- San Pablo Reservoir (38,600 af)
- Lafayette Reservoir (4,300 af)
- Del Valle Reservoir (77,000 af)
- Lake Anza (268 af)
- Lake Temescal (200 af)
- Lake Chabot (10,280 af)
- Cull Canyon Reservoir (310 af)
- Calaveras Reservoir (100,000 af)

Santa Clara County Reservoirs

- Almaden Reservoir (2,000 af)
- Anderson Reservoir (90,000 af)
- Calero Reservoir (9,850 af)
- Coyote Reservoir (23,666 af)
- Lexington Reservoir (21,430 af)
- Stevens Creek Reservoir (3,800 af)
- Vasona Reservoir (410 af)
- Chesbro Reservoir (3,000 af)

Marin County Reservoirs

- Lagunitas Reservoir (341 af)
- Alpine Reservoir (8,892 af)
- Bon-Tempe Reservoir (4,300 af)
- Kent Reservoir (32,900 af)
- Phoenix Reservoir (612 af)
- Nicasio Reservoir (22,400 af)
- Soulajule Reservoir (10,572 af)

SCVWD operates 10 reservoirs for water supply and groundwater recharge. The reservoirs have a total capacity of 169,000 af. The largest is Anderson Reservoir near the City of Morgan Hill with a capacity of 90,000 af. However, five of the reservoirs, including Anderson Reservoir, are kept low while their dams undergo seismic retrofits. Approximately 46,300 af of water storage, 27 percent of the total capacity, is lost during the retrofits which will take years. Additional water storage is lost while SFPUC's Calaveras Dam (100,000 acre-foot capacity) is retrofitted.

Water Quality

The SFRWQCB is the lead agency charged with protecting and enhancing surface water and groundwater quality in the Bay Region. It implements the total maximum daily load (TMDL) Program, which involves determining a safe level of loading for each problem pollutant, determining the pollutant sources, allocating loads to all the different sources, and implementing the load allocations. It is taking a watershed management approach to runoff source issues, including TMDL implementation, by engaging all affected stakeholders in designing and implementing goals on a watershed basis to protect water quality. Representatives from all levels of government, public interest groups, industry, academic institutions, private landowners, concerned citizens, and others are involved in creating watershed action plans. The plans include actions such as improving coordination between regulatory and permitting agencies, increasing citizen participation in watershed planning, improving public education on water quality and protection issues, and prioritizing and enforcing current regulations more consistently.

Surface Water Quality

Despite successful regulation of municipal and industrial wastewater discharges through the National Pollutant Discharge Elimination System (NPDES), many significant surface water quality issues remain to be resolved. Pollutants from urban and rural runoff include pathogens, nutrients, sediments, and toxic residues. Some toxic residues are from past human activities such as mining; industrial production; and the manufacture, distribution, and use of agricultural pesticides. These residues include mercury, PCBs, selenium, and chlorinated pesticides. Emerging pollutants in the region include flame retardants, perfluorinated compounds, nonylphenol fipronil, and pharmaceuticals. The SFRWQCB monitors these pollutants through its Regional Monitoring Program; develops management strategies; and implements actions, including pollution prevention, to reduce them. Sanitary sewer spills can occur because of aging collection systems and treatment plants. Pollutants can spread over large areas, possibly sickening people and pets who contact them. Cleaning up pollutants after flooding is difficult.

San Francisco Bay and a number of the streams, lakes, and reservoirs in the Bay Region have elevated mercury levels, as indicated by elevated mercury levels in fish tissue. The major source of the mercury is local mercury mining and mining activities in the Sierra Nevada and coastal mountains. Large amounts of contaminated sediments were discharged into the bay from Central Valley streams and local mines in the Bay Region. Significant impaired water bodies include the bay, the Guadalupe River in Santa Clara County (from New Almaden Mine), and Walker Creek in Marin County (from Gambonini Mine). The SFRWQCB has adopted TMDLs for mercury in the bay, Guadalupe River, and Walker Creek. Wastewater treatment plants and urban runoff also are a source of mercury, and some wetlands may contain significant amounts of methylmercury (the bioavailable form of mercury in the aquatic environment) from contaminated sediments.

San Francisco Bay is a nutrient-enriched (nitrogen and phosphorus) estuary, but has not suffered from some of the problems found in other similar estuaries with high nutrient concentrations. Dissolved oxygen concentrations in the bay's subtidal habitats are much higher, and phytoplankton levels are substantially lower than expected in an estuary with such high nutrient enrichment. The phytoplankton growth is limited by strong tidal mixing, reduced sunlight due to high turbidity, and grazing clams.

However, evidence suggests that the historical resilience of San Francisco Bay to the harmful effects of nutrient enrichment is weakening. Since the late 1990s, the bay has experienced significant increases in phytoplankton biomass from Suisun Bay to the South Bay (30 to 105 percent), and significant declines in dissolved oxygen concentrations (2 to 4 percent). Also, cyanobacteria and dinoflagellate (red tide) blooms are occurring in portions of the bay. The SFRWQCB is working collaboratively with stakeholders to evaluate the impacts of nutrients on water quality and to develop a regional nutrient management strategy.

Sediments are dredged from San Francisco Bay to maintain navigation through shipping channels for commercial and recreational purposes. Long-term management strategies were established in 1998 to dispose of the sediments. These strategies include eliminating unnecessary dredging, disposing dredged material in the most environmentally sound manner, and maximizing the use of dredged material as a resource.

Before 1998, more than 80 percent of dredged sediments were disposed in the bay and less than 20 percent were disposed in the ocean or were reused on uplands. The goal of the long-term management strategies is to reverse these percentages so that in-bay disposal decreases and more dredged material is used, preferably for wetland restoration. SFRWQCB guidelines allow only sediments with acceptable levels of contaminants to be reused.

The quantity and quality of biological resources has declined in San Francisco Bay partly because of contaminants. Fewer fish and other aquatic and riparian species reside in the bay. Some species have significant levels of contaminants, which threaten their health and reproduction and necessitate health advisories discouraging consumption of the species.

Non-native invasive species are considered a growing water quality threat as they have reduced or eliminated populations of many native species, disrupted food webs, eroded marshes, and interfered with boating and other water contact recreation. San Francisco Bay is considered one of the most highly invaded estuaries in the world. Exotic and invasive species, such as the Chinese Mitten Crab, New Zealand Mud Snail, Asian Clam, and Atlantic Spartina (Cordgrass) threaten to alter the estuary's ecosystem and undermine its food web. The SFRWQCB, DFW, and other agencies have developed the California Aquatic Invasive Species Management Plan, which focuses on early detection of invasive species, risk assessment of the primary introduction vectors, improved coordination among agencies, and rapid response actions. The State Coastal Conservancy has developed the Invasive Spartina Plan to address the threat from non-native Spartina.

The rate and timing of freshwater inflows are among the most important factors influencing the physical, chemical, and biological conditions in San Francisco Bay. Retaining adequate freshwater inflows to the bay is critical to protect migrating fish and estuarine habitat. Adequate inflows are necessary to control salinity, to maintain proper water temperature, and to flush out residual pollutants that cannot be eliminated by treatment or source management.

The Sacramento and San Joaquin rivers flow into the eastern end of Suisun Bay, contributing most of the freshwater inflows to the bay. Many small rivers and streams also contribute fresh water. Much of the fresh water is impounded by upstream dams and is diverted to various water projects; which provide vital water to industries, farms, homes, and businesses throughout the state. The SFRWQCB, the Central Valley Regional Water Quality Control Board, the SWRCB, and other stakeholders are working to improve bay water quality by finding solutions to complex diversion issues. These agencies have formed the Bay-Delta Team to implement a long-term program that addresses impacts to beneficial uses of water in the bay and the Delta.

Another water quality problem in the Bay Region is from stream channel erosion. An excess of sediment can be conveyed downstream, which leads to loss of riparian habitat and loss of spawning habitat for native salmonids. Stream erosion is accelerated by urbanization and additional impervious surfaces, land use conversion, rural development, and grazing. Many watersheds in the region are impaired by excessive sedimentation, a lack of large woody debris, and a lack of spawning gravels. The SFRWQCB addresses these issues through its stormwater program, which regulates construction activities and controls erosion from developments; through working with flood control agencies on stream maintenance; and through its TMDL program, which sets load limits for discharge from sources such as roads, confined animal facilities, vineyards, and grazing lands. The SFRWQCB also directs technical assistance and grant funding to locally managed watershed programs working on restoration projects and education and outreach efforts.

The SFRWQCB regulates wastewater discharged into coastal ocean waters in the Bay Region and regulates use of the California Ocean Plan, which SWRCB adopted in 1972. The plan establishes water quality standards that regulate California's coastal ocean waters and the regional basin plan. The latest ocean plan can be viewed at http://www.waterboards.ca.gov/water_issues/programs/ocean/index.shtml.

Groundwater Quality

Drought, overdraft, and pollution have impaired portions of 33 groundwater basins in the Bay Region. The basins face a perpetual threat of contamination from spills, leaks, and discharges of solvents, fuels, and other pollutants. Contamination affects the supply of potable water and water for other beneficial uses. Some municipal, domestic, industrial, and agricultural supply wells have been removed from service due to the presence of pollution, mainly in shallow groundwater zones. Overdraft can result in land subsidence and saltwater intrusion, although active groundwater management has stopped or reversed the saltwater intrusion.

A variety of historical and ongoing industrial, urban, and agricultural activities and their associated discharges have degraded groundwater quality. Such discharges include industrial and agricultural chemical spills, underground and above-ground tank and sump leaks, landfill leachate, septic tank failures, and chemical seepage via shallow drainage wells and abandoned wells. The Bay Region has over 800 groundwater cleanup cases, about half of which are fuel cases. In many cases, the treated groundwater is discharged to surface waters via storm drains. High priority cleanup cases include Department of Defense sites such as Hunter’s Point, Point Molate, Point Isabel, and the “Brownfields” sites (in general, these are contaminated former industrial sites in urban areas that are suitable for redevelopment).

The SFRWQCB issues NPDES permits for discharge of treated groundwater polluted by fuel leaks and service stations wastes and by volatile organic compounds. It also issues permits for reverse osmosis concentrate from aquifer protection wells, for salinity barrier wells, and for high volume dewatering of structures. As additional discharges are identified, source removal, pollution containment, and cleanup must be undertaken as quickly as possible to ensure that groundwater quality is protected.

Much of the Bay Region’s groundwater is considered to be an existing or potential source of drinking water. However, some groundwater is not, such as shallow or saline groundwater around the perimeter of San Francisco Bay. Successful groundwater management in the region ensures that groundwater basins provide high quality water for drinking; irrigation; industrial processes; and the replenishment of streams, wetlands, and San Francisco Bay.

The agencies in the region have implemented various quality programs to monitor and protect groundwater quality. The Sonoma Valley County Sanitation District (SVCSD), Zone 7, and SCVWD are developing Salt and Nutrient Management Plans to ensure that Bay Region groundwater basins are protected, as required by SWRCB’s Recycled Water Policy. Also, SVCSD is developing a new guidance document to help local water agencies develop their own Salt and Nutrient Management Plans. The goal of the plans is to reduce the salts and nutrients that enter the region’s groundwater basins.

Drinking Water Quality

Drinking water in the Bay Region ranges from high-quality Mokelumne River and Tuolumne River water to variable-quality Delta water, which constitutes about one-third of the domestic water supply. Purveyors that depend on the Delta for all or part of their domestic water supply can meet drinking water standards, but still need to be concerned about microbial contamination, salinity, and organic carbon.

The SFRWQCB contributed to the 2012 Draft Report, "Communities that Rely on Contaminated Groundwater", which assesses community drinking water systems in the region. While most community drinking water systems comply with drinking water standards, the report identifies 28 wells in 18 water systems that rely on contaminated groundwater. A well is considered contaminated if a primary drinking water standard is exceeded. Most of the affected systems are small systems which often need financial assistance to construct a water treatment plant or another facility to meet drinking water standards. The most prevalent contaminants are nitrate, arsenic, and aluminum.

Groundwater Conditions and Issues

Groundwater Occurrence and Movement

Aquifer conditions and groundwater levels change in response to varying supply, demand, and climate conditions. During dry years or periods of increased use of groundwater supply, seasonal groundwater levels tend to fluctuate more widely and, depending on annual recharge conditions, may result in a long-term decline in groundwater levels, both locally and regionally. Depending on the amount, timing, and duration of groundwater level decline, nearby well owners may need to deepen wells or lower pumps to regain access to groundwater.

Lowering of groundwater levels can also impact the surface water–groundwater interaction by inducing additional infiltration and recharge from surface water systems, thereby reducing the groundwater discharge to surface water base flow and wetlands areas. Extensive lowering of groundwater levels can also result in land subsidence due to the dewatering, compaction, and loss of storage within finer grained aquifer systems.

During years of normal or above normal precipitation, or during periods of low groundwater extraction, aquifer systems tend to recharge and respond with rising groundwater levels. As groundwater levels rise, they reconnect to surface water systems, contributing to surface water base flow or wetlands, seeps, and springs.

The movement of groundwater is from areas of higher hydraulic potential to areas of lower hydraulic potential, typically from higher elevations to lower elevations. The direction of groundwater movement can also be influenced by groundwater extractions. Where groundwater extractions are significant, groundwater may flow toward the extraction point. Rocks with low permeability can restrict groundwater flow through a basin. For example, a fault may contain low permeability materials and restrict groundwater flow.

Depth to Groundwater

The depth to groundwater has a direct bearing on the costs associated with well installation and groundwater extraction operations. Understanding the local depth to groundwater can also provide a better understanding of the local interaction between the groundwater table and the surface water systems, and the contribution of groundwater aquifers to the local ecosystem.

Groundwater levels in the region are highly variable from basin to basin. Because of resource and time constraints, depth-to-groundwater contours for the region could not be developed as part of the groundwater content enhancement for Update 2013. However, depth-to-groundwater data for some of the groundwater basins in the region are available online via DWR’s Water Data Library, DWR’s CASGEM system, and the USGS National Water Information System. In addition, basin-specific information may be obtained from the following sources.

- Napa Valley Subbasin – Napa County (http://www.countyofnapa.org/)
- Sonoma Valley Subbasin - Sonoma County Water Agency (http://www.scwa.ca.gov/svgroundwater/)

- Santa Clara Valley Basin - Santa Clara Valley Water District (http://www.valleywater.org/Services/GroundwaterMonitoring.aspx)
- Niles Cone Subbasin - Alameda County Water District (http://www.acwd.org/)
- East Bay Plain Subbasin - East Bay Municipal Utilities District (http://www.ebmud.com/water-and-wastewater/project-updates/south-east-bay-plain-basin-groundwater-management)
- Livermore Valley Basin - Zone 7 Water Agency (http://www.zone7water.com/publications-reports/reports-planning-documents)
- Westside Basin: San Francisco Public Utilities Commission (http://www.sfwater.org/)

Groundwater Elevations

Groundwater elevation contours can help estimate the direction of groundwater movement and the gradient, or rate, of groundwater flow. DWR monitors the depth to groundwater in some groundwater basins within the region; but because of resource and time constraints, groundwater elevation contours for the region could not be developed as part of the groundwater content enhancement for Update 2013. Some references and links to local agencies that independently or cooperatively monitor the groundwater levels in the basins and develop groundwater elevation maps have been provided in the previous section.

Groundwater Level Trends

Plots of depth-to-water measurements in wells over time (groundwater level hydrographs) allow analysis of seasonal and long-term groundwater level variability and trend over time. Because of the highly variable nature of the physical aquifer systems within each groundwater basin, and because of the variable nature of annual groundwater availability, recharge, and surrounding land use practices, the hydrographs presented herein do not attempt to illustrate or depict average aquifer conditions over a broader region. Rather, the selected hydrographs are intended to help tell a story about how the local aquifer systems respond to changing groundwater pumping quantity and to the implementation of resource management practices. The hydrographs are designated according to the State Well Number System (SWN), which identifies each well by its location using the public lands survey system of township, range, section, and tract.

<u>Hydrographs 06N04W27L002M and 05N03W05M001M</u>

Hydrographs 06N04W27L002M (Figure SFB-15-A) and 05N03W05M001M (Figure SF-15-b) are from two domestic wells located in the Napa Valley Subbasin, approximately 4 miles apart. The two wells reflect the dramatically different aquifer conditions underlying the subbasin, conditions resulting from complex hydrogeology, relative distance from major surface water systems, and surface recharge conditions. Well 06N04W27L002M is completed in the upper Sonoma Volcanics and within younger, unconsolidated alluvial deposits. It has historically shown a very stable groundwater level trend since the 1960s, likely due to its relatively short distance from and interaction with surface water from the Napa River. In contrast, well 05N03W05M001M is completed in the less-permeable portion of the Sonoma Volcanics and has shown considerable groundwater level decline, approximately 3 feet per year, since it was first monitored in 1949 (U.S. Geological Survey 2003). Well 05N03W05M001M is considered by Napa County to be located in a “groundwater deficient area” and is subject to a countywide groundwater ordinance that was first adopted in 1996. Napa County does not have a Groundwater Management Plan but is currently developing a countywide groundwater monitoring program to complement the CASGEM Program and to better characterize its groundwater resources.

Hydrograph 04N05W02B001M

Hydrograph 04N05W02B001M (Figure SFB-15-C) is from a domestic well located in the southern Sonoma Valley Subbasin, a predominantly agricultural area. The hydrograph illustrates the effect of in-lieu recharge on declining groundwater levels and the associated response when recycled water supplies were made available to the area around 1996. Groundwater levels prior to 1990 were generally stable at around 5 feet above mean sea level, however, dropped to approximately 120 feet below mean sea level by 1996. The drop in groundwater level created a depression zone near the City of Sonoma which caused saline water to migrate northward into the subbasin. In the mid-1990s, the SCWA and the City of Sonoma initiated a saltwater intrusion control program and made recycled water available for irrigation, which offset the need for groundwater pumping for irrigation and allowed groundwater levels to recover. Between 1996 and 1998, groundwater levels recovered 120 feet and have been above mean sea level for more than 10 years. SCWA prepared a Groundwater Management Plan for the Sonoma Valley in 2007 and is proactively pursuing a portfolio of water projects to ensure the sustainability of surface water and groundwater resources in Sonoma County.

Hydrograph LMMW-1S

Hydrograph LMMW-1S (Figure SFB-15-D) is from a monitoring well located in the highly urbanized Westside Basin, and is monitored by the SFPUC. The hydrograph represents generally stable groundwater levels in an urban environment primarily due to non-use of groundwater supply for domestic consumption, as the area is served by surface water supplies. As shown in Table SFB-3 San Francisco County has the least number of well records of counties located in the region, and groundwater within the county is not widely used for domestic, irrigation, public supply, or industrial purposes. Of about 1,550 available well records in the county, about 1,200 (79 percent) are monitoring wells likely associated with groundwater cleanup programs. Because the county is heavily reliant upon imported surface water supplies, SFPUC is developing groundwater resources in the Westside Basin for more reliable groundwater supplies.

Hydrograph 04S01W30E003M

Hydrograph 04S01W30E003M (Figure SFB-15-E) is from a well located in an urban area of the Niles Cone Subbasin. The hydrograph is another illustration of groundwater level recovery resulting from availability of imported surface water supplies and implementation of groundwater recharge efforts. Salt water intrusion was first noticed in the Niles Cone Subbasin in the 1920s, a result of decades of persistent pumping in the area. ACWD began purchasing imported water from the SWP in 1962 to supplement local water supplies and to increase the amount of water available for local groundwater recharge through percolation ponds. The additional water supplies and the groundwater recharge efforts resulted in decreased groundwater pumping and recovering groundwater levels. In the 1970s, ACWD constructed inflatable dams in Alameda Creek to further increase recharge capabilities in the groundwater basin.

Hydrograph 07S01E07R013M

Hydrograph 07S01E07R013M (Figure SFB-15-F) is from a municipal water supply well located in Santa Clara County. The hydrograph is a classic example of how conjunctive management of water supplies help offset the effects of population increase, land use changes, and land subsidence on groundwater levels. The earliest recorded groundwater level is 100 feet above mean sea level in 1915 (not shown in Figure SFB-15-F). By 1935, groundwater levels dropped to approximately 5 feet above mean sea level due to intensified pumping activity. In 1935, SCVWD constructed reservoirs to capture more local surface water which reversed the declining trend in groundwater levels. The groundwater conditions improved until mid-1940s when increase in population and a shift in land use again intensified groundwater extraction in the region. By 1964, the groundwater levels decreased to almost 135 feet below mean sea level.

Stress on the groundwater basin first due to intensified pumping and then due to increased population and shift in land use caused land subsidence to become a significant problem in the Santa Clara Valley groundwater basin. A 13-foot subsidence was recorded in San Jose between 1915 and 1970. In 1964, SCVWD began receiving the first deliveries of imported water from the SWP; and in 1987, SCVWD increased its deliveries of imported water from the federal government. Along with increased surface water deliveries, implementing an in-lieu recharge program and technology changes and water conservation programs, SCVWD successfully reversed the downward trend in groundwater levels, halted land subsidence in the area, and stabilized groundwater levels at approximately 100 feet above mean sea level. SCVWD's Groundwater Management Plan of 2001 also set subsidence thresholds. The Groundwater Management Plan has recently been updated for the groundwater subbasins in the Santa Clara Valley Basin managed by SCVWD.

PLACEHOLDER Figure SFB-15 Groundwater Level Trends in Selected Wells in the San Francisco Bay Hydrologic Region

Change in Groundwater Storage

Change in groundwater storage is the difference in stored groundwater volume between two time periods. Examining the annual change in groundwater storage over a series of years helps identify the aquifer response to changes in climate, land use, or groundwater management over time. If the change in storage is negligible over a period represented by average hydrologic and land use conditions, the basin is considered to be in equilibrium under the existing water use scenario and current management practices. However, declining storage over a period characterized by average hydrologic and land use conditions does not necessarily mean that the basin is being managed unsustainably or subject to conditions of overdraft. Utilization of groundwater in storage during years of diminishing surface water supply, followed by active recharge of the aquifer when surface water or other alternative supplies become available, is a recognized and acceptable approach to conjunctive water management. *Additional information regarding the risks and benefits of conjunctive management can be found online in Update 2013, Volume 3, Chapter 9, "Conjunctive Management and Groundwater Storage."*

Because of resource and time constraints, changes in groundwater storage estimates for basins within the region were not developed as part of the groundwater content enhancement for Update 2013. However, some local groundwater agencies within the region periodically develop change-in-groundwater-storage estimates for basins within their service area, for example, Zone 7 Water Agency (http://www.zone7water.com/), SFPUC (http://www.sfwater.org/), and SCVWD (http://www.valleywater.org/).

Flood Management

Major floods occur regularly in the Bay Region. The floods can be from creeks and rivers, local stormwater runoff, or from levee failures. Many streams in the Bay Region flood repeatedly, such as the Napa River, which has flooded Napa Valley several times causing widespread structural losses and agricultural damages. Floods can be flash floods or debris-flow floods and can inundate urban or coastal areas. Flood damage has been recorded in the region since 1861-1862, when the devastating Great Flood inundated large areas of the West Coast, including the San Francisco Bay area. Refer to the California Flood Future Report, Attachment C: Flood History of California for a complete list of floods (http://www.water.ca.gov/sfmp/flood-future-report.cfm).

Flood Hazard Exposure

The Bay Region has more than 350,000 people who are exposed to flooding from a 100-year flood, and more than 1 million people who are exposed to flooding from a 500-year flood. The 500-year floodplain contains approximately 550,000 acres of land and 322,000 structures. The value of the exposed structures and public infrastructure in the 500-year floodplain is over $130 billion. The value of exposed crops is only $23.9 million. The majority of exposure is in Santa Clara County; which has more than 600,000 people and over $80 billion in assets in the 500-year floodplain. Figures SFB-16 and SFB-17 illustrate the 100- and 500-year flood zones, respectively.

A wide variety of projects and programs are implemented to reduce flood damages in the Bay Region. These include structural and non-structural measures; and disaster preparedness, response, and recovery.

PLACEHOLDER Figure SFB-16 San Francisco Bay – Statewide Flood Hazard Exposure to the 100-Year Floodplain

PLACEHOLDER Figure SFB-17 San Francisco Bay – Statewide Flood Hazard Exposure to the 500-Year Floodplain

The region has 150 public agencies that manage floods with 2,588 miles of levees and 222 dams and weirs (Table SFB-12). An additional 121 local projects are planned to alleviate flooding, including several projects which address coastal flooding due to sea level rise, which is a major concern in this densely populated region. Refer to the California Flood Future Report, Attachment G: Risk Information Inventory for a complete list of projects (http://www.water.ca.gov/sfmp/flood-future-report.cfm).

PLACEHOLDER Table SFB-12 Flood Management Agencies, San Francisco Bay Hydrologic Region

Sea Level Rise

One of the most publicized impacts of climate change is a predicted acceleration of sea level rise. This acceleration would increase the historical rate of sea level rise, which has been measured in San Francisco Bay for over 140 years. Between 1900 and 2000, the level of the Bay increased by 7 inches. Depending on which end of the range of projected temperature increases comes about, the California Climate Action Team found that water levels in San Francisco Bay could rise an additional 5 inches to 3 feet, or nearly one meter by the end of this century.

More recent analyses indicate that sea level rise from warming oceans may be 1.43 meters (about 55 inches) over the next 100 years, or even higher depending upon the rate at which glaciers and other ice sheets on land melt. Using GIS data, BCDC has prepared illustrative maps showing that a one-meter rise in the level of the bay could flood over 200 square miles of land and development around the Bay. Using financial support from Caltrans and the California Energy Commission, the Pacific Institute is working in partnership with BCDC to determine the value of the development threatened with inundation. Initial estimates indicate that over $100 billion worth of public and private development could be at risk.

Impacts from sea level rise are most likely to occur in concert with other forces that already contribute to coastal flooding. When superimposed on higher sea levels these conditions will combine to create short-term extremely high water levels that can inflict damage to areas that were not previously at risk. For example, computer models indicate that a one-foot rise in sea level will increase the likelihood that the most extreme storm surge event which now occurs once a century, will occur once every 10 years. While storm impacts cannot be mapped as easily as sea level rise can, it is likely that larger areas will flood during future storm events.

Sea level rise will affect and threaten coastal communities, facilities and infrastructure through more frequent flooding and gradual inundation, as well as increased erosion of coastal bluffs, and river surges affecting local flooding. This will affect roads, utilities, wastewater treatment plants, outfalls, and storm water facilities and systems as well as large wetland areas in addition to towns and cities. Where land is rising — tectonic effects — the rate of sea level rise may be exceeded by the rate of coastal uplift. However, in the North Coastal area the rate of tectonic uplift is greater than current rate of sea level rise.

The risk assessment for flooding is incorporating the vulnerability of the North Coast region based on the rate and magnitude of sea level rise and its impacts. Those communities and facilities at risk are incorporating hazard mitigation measures into planning and management strategies. As the California Flood Futures report identifies, the first strategy is to identify and evaluate sea level rise risks and determine the areas that are most vulnerable to future flooding, inundation, erosion and wave impacts, and to develop hazard mitigation and adaptation plans.

Where coastal bluff erosion is high, coastal cliff retreat is dramatic with collapsed roadways, undermined foundations, dangling decks and stairways and structures. Coastal erosion tends to be episodic, with long-term cliff and bluff failure occurring during a few severe storm events. Scientists consider the probability that these events will increase in frequency and intensity. The California Coastal Commission database for coastal erosion is a valuable resource and available on CD (Dare 2005). A key component to coastal management is understanding the adaptive capacity of the affected areas. This capacity is the ability to prepare for, respond to, and recover from sea level rise impacts.

Damage Reduction Measures

Structural Measures

Structural flood damage reduction measures in the Bay Region are generally local in scope rather than part of a large-scale flood protection system. Important structural measures in the region, such as reservoirs, levees, and channel improvements, protect life and property from the consequences of high water and debris flow.

Three important reservoirs in the region have a designated flood protection function — Lake Chesbro, Lake Del Valle, and Cull Creek Reservoir with 3,000; 38,000; and 310 af of flood control capacity, respectively. SCVWD constructed Lake Chesbro to protect San Jose. Lake Del Valle is a SWP facility that protects Pleasanton, Fremont, Niles, and Union City. Alameda County Flood Control and Water Conservation District (Alameda County FCWCD) constructed Cull Creek Reservoir to protect Castro Valley.

Operation of the reservoirs is not coordinated according to any formal agreement. Each reservoir is operated according to its flood control diagram, which dictates the required flood space reservation throughout the flood season. The required flood space reservation is dependent on the time of year, antecedent precipitation, and runoff forecasts. Maximum reservoir evacuation rates and objective releases also are maintained to limit downstream flooding when possible.

Many channel improvement projects in the region reduce stream flooding. These projects include channel construction, enlargement, realignment, lining, stabilization, and bank protection. U.S. Army Corps of Engineers (USACE) projects were built on Alameda Creek, San Lorenzo Creek, Walnut Creek, Corte Madera Creek, Coyote Creek, Berryessa Creek, Guadalupe River, Napa River, Wildcat and San Pablo Creeks, Green Valley Creek, Pinole Creek, Rheem Creek, Rodeo Creek, San Leandro Creek, and on several streams near Fairfield.

Other projects in the region include bank protection on San Francisco Bay near Emeryville (USACE), a detention basin on Pine Creek above Concord (Contra Costa County FCWCD), sedimentation basins on Wildcat and San Pablo creeks near Richmond (Contra Costa County FCWCD), reservoirs and channel work on several tributaries of Walnut Creek in Diablo Valley (Contra Costa County FCWCD), channel improvements on lower Silver Creek in San Jose (SCVWD), channel stabilization on Cull Creek east of Castro Valley (Alameda County FCWCD), channel improvements on Conn and Tulucay creeks (Napa County FCWCD), and locally constructed and maintained levees at Suisun Marsh and throughout the region. Table SFB-13 shows important flood control facilities in the region.

PLACEHOLDER Table SFB-13 Flood Control Facilities, San Francisco Bay Hydrologic Region

Maintenance of flood control facilities is critical to preserve the integrity of the facilities and to uphold sustained public protection. Maintenance is made difficult by two factors — adequate financing and environmental regulations. Adequate financing is hard to obtain as property taxes and other sources of revenue shrink. Heightened public awareness of the environment has led to a multitude of regulations and required permits, which complicates the maintenance of facilities and increases costs. Ironically, if maintenance is deferred, new habitat might become established and then need to be protected, making maintenance even more difficult. The SFRWQCB is working with flood control entities in the region to minimize deferred maintenance by helping to establish long-term integrated county permits for stream and flood channel maintenance.

County flood control districts, such as Alameda County FCWCD and Napa County FCWCD, maintain many of the flood control facilities in the region, including USACE-constructed facilities. DWR maintains Lake Del Valle, which is part of the SBA (SWP).

Non-Structural Measures

1. Floodplain Regulation

All counties in the Bay Region have ordinances regulating floodplain development and floodplain management, typically as part of their general plan. A number of cities have additional ordinances that further restrict development in areas susceptible to flooding. Floodplain management regulations must be adopted, such as designating 100-year floodways to reduce potential flood damages and to qualify a community for FEMA flood insurance. Officially designated floodways in the region include Cull, Crow Canyon, Alameda, and Arroyo de la Laguna creeks in Alameda County; the Napa River in Napa County; Sonoma and San Antonio creeks in Sonoma County; and Novato Creek in Marin County.

2. Flood Insurance

FEMA administers the National Flood Insurance Program (NFIP), which enables property owners in participating communities to purchase insurance as protection against flood losses. About 97 percent of California communities participate in the NFIP. Of those, approximately 12 percent participate in the Community Rating System (CRS) Program, which encourages communities to go beyond minimum NFIP requirements in return for reduced insurance rates.

CRS rates communities from 1 to 10 on the effectiveness of flood protection activities. The lower ratings bring larger discounts on flood insurance. In the Bay Region, 4 of the 9 counties and 20 cities participate in CRS. As of May 2009, Contra Costa County, Milpitas, and Petaluma are in CRS Class 6; Alameda County, Solano County, Fremont, Palo Alto, San Jose, Sunnyvale, and Walnut Creek are in CRS Class 7; Concord, Corte Madera, Cupertino, Los Altos, Mountain View, Napa, Novato, Pleasant Hill, Pleasanton, San Leandro, San Ramon, and Santa Clara are in CRS Class 8; Richmond is in CRS Class 9, and Santa Clara County is in CRS Class 10. See http://www.fema.gov/business/nfip/crs.shtm for more information on the CRS system.

Quality mapping is critical to administer an effective flood insurance program, which includes developing accurate hydrologic and hydraulic modeling to delineate floodplain boundaries. FEMA has developed Flood Insurance Rate Maps (FIRMs) for all counties in the Bay Region. The FIRMs were update in 2008, except for the San Francisco County FIRM which was updated in 2007.

3. Disaster Preparedness, Response, and Recovery

The Federal Disaster Mitigation Act of 2000 emphasizes pre-disaster mitigation and mitigation planning. In order to receive federal hazard mitigation funds, all local jurisdictions must adopt a hazard mitigation plan and provide technical support for executing the plan. A hazard mitigation plan identifies hazards, risks, and mitigation actions and their priorities. Alameda, Contra Costa, San Mateo, Santa Clara, and Solano counties have annexed the Association of Bay Area Governments (ABAG) Multi-Jurisdictional Hazard Mitigation Plan; while Marin, Napa, San Francisco, and Sonoma counties have adopted their own plans. All plans have received California Emergency Management Agency (Cal EMA) approval.

Many agencies in the Bay Region have some level of flood planning. The City of Napa has a system of road closures based on the stage of the Napa River, which reduces the risk to individuals and property in the event of flooding. The Contra Costa Resource Conservation District has a watershed management plan for Alhambra Creek, which discusses a myriad of options to reduce the risk of flooding in Martinez and surrounding areas. The Bay Area Flood Protection Agencies Association (BAFPAA) is a consortium of flood control and water agencies in the region that provides a forum for discussing flood issues, collaborating on multi-agency projects, and sharing resources.

Accurate hydrologic and hydraulic models are needed to provide valuable river flow and stage forecasts that alert flood emergency personnel where flood -fighting might be necessary. The National Weather Service (NWS) has an Advanced Hydrologic Prediction Service (AHPS) that forecasts weather and river flows and stages. Its California-Nevada River Forecast Center provides forecasts at four locations in the Bay Region — Coyote Creek at Coyote Reservoir, Los Gatos Creek at Lexington Reservoir, Napa River at Saint Helena, and Napa River at Napa.

Water Governance

Water governance in the Bay Region consists of a diverse body of water supply, wastewater management, flood protection, and land use agencies. The water supply agencies have a history of working together on water resource management issues through the Bay Area Water Agencies Coalition. BAWAC enables the agencies to capitalize on collective resources, expertise, and knowledge to achieve water quality and water supply reliability goals.

There are many wastewater management agencies in the Bay Region, including cities, sanitation districts, community services districts, counties, and other local agencies. Like water supply agencies, wastewater management agencies have recognized the value in regional cooperation and collaboration as a means of advancing shared interests and resolving common issues. Many wastewater agencies are represented by BACWA, which has a long history of providing a forum for coordination on regional wastewater management issues.

The Bay Region flood protection agencies have a history of working together on water resource management issues through BAFPAA. The association promotes the sharing of ideas, technologies, experiences, legislative approaches, and funding strategies. It also provides a forum for regional coordination and collaboration with state and federal regulatory and resource agencies. BAFPAA has 10 agencies as signatories: Alameda, Contra Costa, Marin, Napa and San Mateo County FCWCD; the City and County of San Francisco Department of Public Works; SCVWD; and Solano County, Sonoma County, and Zone 7 water agencies. These Bay Area agencies also coordinate their stormwater policies and projects through the Bay Area Stormwater Management Agencies Association (BASMAA).

Land use planning in the Bay Region typically takes place through local city and county governments; as well as through ABAG, the Metropolitan Transportation Commission (MTC), and the Joint Policy Committee (JPC). ABAG is the Council of Government (COG) for the Bay Area. As the primary regional land use planning agency, ABAG represents nearly all of the region's population. It strives to enhance cooperation and coordination between local governments to reach regional planning goals. MTC is the Metropolitan Planning Organization (MPO) for federal transportation purposes and is the transportation planning, coordinating, and financing agency for Bay Area Rapid Transit (BART) and other major regional transit systems. JPC coordinates the regional planning efforts of ABAG, the Bay Area Air Quality Management District (BAAQMD), BCDC, and MTC and pursues implementation of the region's Smart Growth Vision. (See Box SFB-3.)

PLACEHOLDER Box SFB-3 Planning Organizations, San Francisco Bay Hydrologic Region

In July 2013, ABAG and MTC adopted the Plan Bay Area, which is an integrated transportation and land-use strategy to meet the requirements of Senate Bill 375 for a Sustainable Communities Strategy to accommodate future population growth and reduce greenhouse gas (GHG) emissions from cars and light trucks (Steinberg 2008). The plan provides a strategy for meeting 80 percent of the region's future housing needs in Priority Development Areas (PDAs) or neighborhoods within walking distance of frequent transit service and mixed uses of residential and commercial.

DWR has accepted two Bay Region IRWM groups. Figure SFB-18 shows the two groups — the San Francisco Bay Area IRWM group and the ECCC IRWM group. The Bay Area group conducts the majority of IRWM planning in the region. The ECCC group primarily conducts IRWM planning for

Eastern Contra Costa County, but a small portion of the group is within the Bay Region boundary. These groups develop IRWM plans, which are living documents that change as planning efforts mature, opportunities for collaboration and partnership are discovered, and State guidance is refined further. The water management priorities and stakeholder relationships of each group are unique, and they are committed to meeting regional water needs. The diverse stakeholder groups recognize that more regional or subregional collaboration is needed.

PLACEHOLDER Figure SFB-18 Integrated Regional Water Management Groups in the San Francisco Bay Hydrologic Region

San Francisco Bay Area IRWM Group

The Bay Area IRWM Group is developing important water management information to update its IRWM Plan, which was an important resource for this San Francisco Bay Regional Report. The IRWM Plan addresses 16 IRWM Plan Standards, including resource management strategies and climate change, which are discussed in the Looking to the Future chapter.

The Bay Area IRWM Group was formed through a collaborative process beginning in 2004. The original group participants include:

- Alameda County Water District
- Association of Bay Area Governments
- Bay Area Clean Water Agencies
- Bay Area Water Supply and Conservation Agency
- Contra Costa County Flood Control and Water Conservation District
- Contra Costa Water District
- East Bay Municipal Utility District
- Marin Municipal Water District
- City of Napa
- North Bay Watershed Association
- City of Palo Alto
- San Francisco Public Utilities Commission
- City of San Jose
- Santa Clara Basin Watershed Management Initiative
- Santa Clara Valley Water District
- Solano County Water Agency
- Sonoma County Water Agency
- Sonoma Valley County Sanitation District
- State Coastal Conservancy
- Zone 7 Water Agency

The group is organized into four Functional Areas:

1. Water Supply & Water Quality
2. Wastewater & Recycled Water
3. Flood Protection & Stormwater Management
4. Watershed Management & Habitat Protection and Restoration

Representatives from agencies that were active in the Functional Areas formed a Coordinating Committee (CC), which serves as the governing body of the group and provides oversight for updating the IRWM Plan. The CC now includes representatives from Bay Area water supply agencies, wastewater agencies, flood control agencies, ecosystem management and restoration agencies, regulatory agencies, nongovernmental organizations, and members of the public.

The CC provides opportunities for all stakeholders and interested parties to participate in the Bay Area IRWM Group and its update to the IRWM Plan. Stakeholders include water supply agencies, recycled water and wastewater agencies, stormwater and flood control agencies, utilities, watershed and habitat conservation groups, regulatory agencies, disadvantaged communities, Native Americans, environmental justice groups and communities, industrial and agricultural organizations, park districts, educational institutions, well owners, developers and landowners, elected representatives, adjacent IRWM groups, municipalities and local governments, and State and federal agencies.

The CC has developed east, west, south, and north subregion groups because integrated water management throughout the Bay Region is challenging and can be more effective by dividing the region based on demographics and geography. The subregion groups provide stakeholder outreach and project solicitation for integration into the IRWM Plan.

The CC also has established four subcommittees to accomplish specific tasks for the Bay Area IRWM Group. These subcommittees include:

1. The Plan Update Team (PUT), which is the primary work group for the IRWM Plan Update.
2. The Project Screening Subcommittee, which works with the subregion groups to obtain project proposals, reviews the proposals to ensure that they are in accordance with DWR guidelines, and identifies synergies and encourages collaboration.
3. The Website and Data Management Subcommittee, which ensures that the Web site is a reasonable communication and information tool for CC members and stakeholders, and ensures that data are consistent with State requirements.
4. The Planning and Process Subcommittee, which analyzes issues and performs specific work tasks as needed, and recommends potential actions to the CC.

Through its subregions, the CC has solicited stakeholders for potential projects that support DWR's IRWM Guidelines and the goals and objectives of the Bay Area IRWM Plan. A list of over 330 potential projects was compiled, including over 120 projects proposed to benefit disadvantaged communities. The projects were reviewed and scored according to a sophisticated scoring methodology that assigns projects into one of three tiers. The 50 highest scoring projects were placed in the top tier and are a priority to construct. The Bay Area IRWM Group is proposing to implement 19 of these projects soon with the help of $20 million in Proposition 84 Implementation Grant funding. See Project Implementation for more information on the 19 projects. Also see http://bairwmp.org/projects for full descriptions and scores of all potential projects.

The CC has achieved consensus on all issues requiring a decision. However, if the CC is not able to reach consensus on an issue, then a vote may be taken. Twelve members vote — three members from each of the four Functional Areas.

State Funding Received

The Bay Region has received millions of dollars in State funding to implement IRWM projects since *California Water Plan Update 2009.* This funding includes Proposition 84 and Proposition 1E grant funding. Some noteworthy IRWM projects receiving these funds include:

Proposition 84

- **Mokelumne Aqueduct Interconnection Project (EBMUD; $10 million Interregional Grant).** This project improves the reliability of the Mokelumne Aqueducts by interconnecting them on both sides of the Delta. The interconnections maximize transmission capacity should one or two of the aqueducts be damaged by earthquake or flood in the Delta. Surviving portions of the aqueducts could convey water after a major event until repairs could be made. A 10-mile above-ground portion of the aqueducts is especially vulnerable to damage in the Delta.
- **Bay Area Regional Priority Projects (BACWA; $30,093,592 Implementation Grant).** This consortium of projects incorporates a wide range of water management elements and addresses all of the regional objectives set forth in the San Francisco Bay Area IRWMP. The 23 projects consist of 3 green infrastructure projects, 7 recycled water projects, 3 wetland ecosystem restoration projects, a water conservation project, and 9 integrated projects in DACs (water quality, flood management, ecosystem restoration).

Proposition 1E

- **Phoenix Lake IRWM Retrofit (Marin County FCWCD; $7.661 million Stormwater Flood Management Grant).** This project helps provide 100-year flood protection in Ross Valley, improves aquatic conditions for anadromous salmonids, and enhances public enjoyment of Phoenix Lake.
- **San Francisco Stormwater and Flood Management Priority Projects (SFPUC; $24.147 million Stormwater Flood Management Grant).** These projects are the Sunnydale Flood and Stormwater Management Sewer Improvement Project and the Cesar Chavez Street Flood and Stormwater Management Sewer Improvement Project. The projects improve San Francisco's aging combined sewer system by replacing and installing new sewer lines, which reduces flood damages and improves water quality by increasing the volume of flow receiving secondary treatment before being discharged into San Francisco Bay.
- **Lower Silver Creek and Lake Cunningham Flood Protection Project (SCVWD; $25 million Stormwater Flood Management Grant).** This project consists of channel improvements and modifications at Lake Cunningham to remove 3,800 homes along Lower Silver Creek from the 100-year floodplain. Other project benefits include fewer channel bank failures, enhanced habitat and vegetation, enhanced fish passage, improved water quality, and new recreational amenities for low-income and minority neighborhoods.
- **San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project, East Bayshore Road to San Francisco Bay (San Francisquito Creek JPA; $8 million Stormwater Flood Management Grant).** This project protects more than 1,100 properties from creek flooding when a 100-year flood occurs coincident with a 100-year tide and 26 inches of projected sea level rise.

Local Investment

Bay Region water agencies must contribute matching funds to the Proposition 84 and Proposition 1E projects listed above. These matching funds are:

- Mokelumne Aqueduct Interconnection Project (EBMUD; $2,000,000)
- Bay Area Regional Priority Projects (BACWA; $85,310,000)
- Phoenix Lake IRWM Retrofit (Marin County FCWCD; $6,089,000)
- San Francisco Stormwater and Flood Management Priority Projects (SFPUC; $43,757,500)
- Lower Silver Creek and Lake Cunningham Flood Protection Project (SCVWD; $29,992,397)
- San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project, East Bayshore Road to San Francisco Bay (San Francisquito Creek JPA; $8,700,000)

Groundwater Governance

California does not have a statewide management program or statutory permitting system for groundwater. However, one of the primary vehicles for implementing local groundwater management in California is a groundwater management plan (GWMP). Some agencies utilize their local police powers to manage groundwater through adoption of groundwater ordinances. Groundwater management also occurs through other avenues such as basin adjudication, IRWMPs, Urban Water Management plans, and Agriculture Water Management plans.

Groundwater Management Assessment

Figure SFB-19 shows the location and distribution of the GWMPs within the region based on a GWMP inventory developed through a joint DWR/Association of California Water Agencies (ACWA) online survey and follow-up communication by DWR in 2011-2012. Table SFB-14 furnishes a list of the same. GWMPs prepared in accordance with the 1992 AB 3030 legislation, as well as those prepared with the additional required components listed in the 2002 SB 1938 legislation are shown. Requirements associated with the 2011 AB 359 (Huffman) legislation, related to groundwater recharge mapping and reporting, did not take effect until January 2013 and are not included in the current GWMP assessment. Information associated with the GWMP assessment is based on data that was readily available or received through August 2012. Some of the GWMPs that were not reviewed as part of Update 2013 because they were received after the initial assessment period include South Westside Basin GWMP (2012) by City of San Bruno, SCVWD GWMP (2012), and South East Bay Plain GWMP (2013) by EBMUD. Sonoma County is split between the North Coast and San Francisco Bay hydrologic regions. The GWMP for the SCWA is presented in this regional report of the San Francisco Bay Hydrologic Region.

PLACEHOLDER Figure SFB-19 Location of Groundwater Management Plans in the San Francisco Bay Hydrologic Region

PLACEHOLDER Table SFB-14 Groundwater Management Plans in the San Francisco Bay Hydrologic Region

The GWMP inventory indicates that four groundwater management plans exist within the region. Three of the four GWMPs are fully contained within the San Francisco Bay Hydrologic Region, while the remaining one plan includes portions of the adjacent Sacramento River Hydrologic Region. All of the four GWMPs cover areas overlying Bulletin 118 Update 2003 (DWR) alluvial groundwater basins. However, two plans also include management areas that extend beyond Bulletin 118-2003 alluvial basins. Collectively, the four GWMPs cover 1,400 square miles. This includes about 600 square miles (43 percent) of the Bulletin 118-2003 alluvial groundwater basin area in the region. Three of the four GWMPs have been developed or updated to include the SB 1938 requirements and are considered active for the purposes of Update 2013 GWMP assessment. As of August 2012, the basin identified as high priority and two of the six basins identified as medium priority under the CASGEM Basin Prioritization (see Table SFB-4) were covered by an active GWMP. The seven high and medium priority basins account for about 60 percent of the population and about 88 percent of groundwater supply in the region.

Based on the information compiled through inventory of the GWMPs, an assessment was made to understand and help identify groundwater management challenges and successes in the region, and provide recommendations for improvement. Information associated with the GWMP assessment is based on data that were readily available or received through August 2012 by DWR. The assessment process is briefly summarized below.

The California Water Code §10753.7 requires that six components be included in a groundwater management plan for an agency to be eligible for State funding administered by DWR for groundwater projects, including projects that are part of an integrated regional water management program or plan (Table SFB-15). Three of the components also contain required subcomponents. The requirement associated with the 2011 AB 359 (Huffman) legislation, applicable to groundwater recharge mapping and reporting, did not take effect until January 2013 and was not included in the current GWMP assessment. In addition, the requirement for local agencies outside of recognized groundwater basins was not applicable for any of the GWMPs in the region.

PLACEHOLDER Table SFB-15 Assessment for SB 1938 GWMP Required Components, SB 1938 GWMP Voluntary Components, and Bulletin 118-2003 Recommended Components

In addition to the six required components, Water Code §10753.8 provides a list of 12 voluntary components that may be included in a groundwater management plan (see Table SFB-15). Bulletin 118-2003, Appendix C provides a list of seven recommended components related to management development, implementation, and evaluation of a GWMP that should be considered to help ensure effective and sustainable groundwater management plan (see Table SFB-15).

As a result, the GWMP assessment was conducted using the following criteria:

- How many of the post-SB 1938 GWMPs meet the six required components included in SB 1938 and incorporated into California Water Code §10753.7?
- How many of the post SB-1938 GWMPs include the 12 voluntary components included in California Water Code §10753.8?
- How many of the implementing or signatory GWMP agencies are actively implementing the seven recommended components listed in DWR Bulletin 118-2003?

In summary, assessment of the GWMPs in the San Francisco Bay Hydrologic Region indicates the following:

- Two of the three GWMPs adequately address all of the required components listed under Water Code §10753.7; one plan that fails to meet all the required components, does not address the Basin Management Objective (BMO) and Monitoring Protocol subcomponents for surface water-groundwater interaction. Analysis of the GWMPs for other regions also reveals that when a plan lacks BMO details for surface water and groundwater interaction, it generally lacks details for Monitoring Protocols as well.

- Two of the three GWMPs incorporate the 12 voluntary components listed in Water Code §10753.8, and the remaining plan incorporates only four of the 12 voluntary components.
- Two of the three GWMPs include all seven components, and the remaining plan only includes the management area component recommended in Bulletin 118-2003.

The DWR/ACWA survey asked respondents to identify key factors that contributed to the successful implementation of the agency's GWMP. Five agencies from the region participated in the survey. Four responding agencies identified that all the factors were important with the exception of State funding for groundwater management programs and stronger coordination with land use agencies; three of the five responding agencies identified outreach and education as a key factor contributing to successful implementation of GWMP. At least one respondent listed State funding for groundwater planning efforts and coordination with land use agencies as contributing factors to successful implementation of GWMPs.

Survey participants were also asked to identify factors that impeded implementation of the GWMP. Three survey respondents pointed to a lack of adequate funding as an impediment to GWMP implementation. Funding is a challenging factor for many agencies because the implementation and the operation of groundwater management projects typically are expensive and because the sources of funding for projects typically are limited to either locally raised monies or to grants from State and federal agencies. Unregulated groundwater pumping, limited participation across a broad distribution of interests, and inadequate surface storage and conveyance capacity were also identified as factors that impede successful implementation of GWMPs.

Finally, the survey asked if the respondents were confident in the long-term sustainability of their current groundwater supply. All the respondents felt long-term sustainability of their groundwater supply was possible.

The responses to the survey are furnished in Tables SFB-16 and SFB-17. *More detailed information on the DWR/ACWA survey and assessment of the GWMPs are available online from Update 2013, Volume 4, Reference Guide , the article "California's Groundwater Update 2013."*

PLACEHOLDER Table SFB-16 Factors Contributing to Successful Groundwater Management Plan Implementation in the San Francisco Bay Hydrologic Region

PLACEHOLDER Table SFB-17 Factors Limiting Successful Groundwater Management Plan Implementation in the San Francisco Bay Hydrologic Region

Groundwater Ordinances

Groundwater ordinances are laws adopted by local authorities, such as cities or counties, to manage groundwater. In 1995, the California Supreme Court declined to review a lower court decision (*Baldwin v. Tehama County*) that says State law does not occupy the field of groundwater management and does not prevent cities and counties from adopting ordinances to manage groundwater under their police powers. Since 1995, the *Baldwin v. Tehama County* decision has remained untested; thus the precise nature and extent of the police power of cities and counties to regulate groundwater is still uncertain.

A number of groundwater ordinances have been adopted by counties in the region (Table SFB-18). The most common ordinances are associated with groundwater wells. These ordinances regulate well construction, abandonment, and destruction; however, none of the ordinances provide for comprehensive groundwater management.

PLACEHOLDER Table SFB-18 Groundwater Ordinances that Apply to Counties in the San Francisco Bay Hydrologic Region

Special Act Districts

Greater authority to manage groundwater has been granted to a few local agencies or districts created through a special act of the Legislature. The specific authority of each agency varies, but the agencies can be grouped into two general categories: (1) agencies having authority to limit export and extraction (upon evidence of overdraft or threat of overdraft) or (2) agencies lacking authority to limit extraction, but having authority to require reporting of extraction and to levy replenishment fees.

Within the San Francisco Bay Hydrologic Region, SCVWD is considered a Special Act District with groundwater management authority. SCVWD was formed in 1929 by an act of the California legislature through the Santa Clara Valley Water District Act for the purpose of providing comprehensive management for all beneficial uses and protection from flooding within the county. Per Sections 4 and 5 of the act, SCVWD's objectives and authority related to groundwater management are to recharge groundwater basins, conserve, manage and store water for beneficial and useful purposes, increase water supply, protect surface water and groundwater from contamination, prevent waste or diminution of the SCVWD's water supply, and do any and every lawful act necessary to ensure that sufficient water is available for present and beneficial uses (Santa Clara Valley Water District Groundwater Management Plan 2012).

Court Adjudication of Groundwater Rights

Another form of groundwater management in California is through the courts. There are currently 24 groundwater adjudications in California. The San Francisco Bay Hydrologic Region contains none of those adjudications.

Other Groundwater Management Planning Efforts

Groundwater management also occurs through other avenues such as IRWMPs, Urban Water Management plans, and Agriculture Water Management plans. Box SFB-4 summarizes these other planning efforts.

PLACEHOLDER Box SFB-4 Other Groundwater Management Planning Efforts in the San Francisco Bay Hydrologic Region

Current Relationships with Other Regions and States

The Bay Region is a major importer of water supplies from other regions of California, as shown previously by Table SFB-7. The North Bay imports water from several sources including the Russian and Eel rivers, Putah Creek, the NBA (SWP), and Vallejo Permit Water. SCWA delivers water from the Russian River (North Coast Hydrologic Region) to Sonoma and Marin counties through the Petaluma and Sonoma aqueducts. The Russian River includes water that is diverted from the Eel River via the Potter

Valley Project, which now diverts significantly less water following Federal Energy Regulation Commission relicensing.

The SWP delivers water through the NBA to Solano County Water Agency and Napa County FCWCD. The NBA extends more than 27 miles from Barker Slough to the Napa Turnout in southern Napa County. The maximum SWP entitlement is 67 taf annually. Solano County Water Agency also gets water from Putah Creek (Lake Berryessa) via the Putah South Canal, a major component of USBR's Solano Project. The project began operating in 1959 and delivers a dependable annual supply of 207 taf; much of which is for agricultural users in the Sacramento River Region.

The City of Vallejo obtained a water right during World War II to divert Sacramento River water from Cache Slough to supply the city and for National Defense needs. The aging diversion facilities became increasingly costly to maintain so the city opted to purchase capacity in the NBA when it was being developed. Vallejo Permit Water now is diverted from Barker Slough along with the other NBA water. The average annual diversion is 22,500 af. The old Cache Slough facilities were not abandoned and could be used for future diversions.

The southern and eastern areas of the Bay Region import water from the Mokelumne and Tuolumne rivers, the Contra Costa Canal (CVP), the San Felipe Unit (CVP), and the SBA (SWP). EBMUD delivers Mokelumne River water to much of Alameda and Contra Costa counties through three pipelines, which serve 1.34 million people with an annual water supply of about 201 taf (2010 census). EBMUD also contracts with USBR to divert Sacramento River water at the Freeport Regional Water Facility to provide water for its customers during drought. SFPUC delivers Tuolumne River water to the City and County of San Francisco via the 150-mile-long Hetch Hetchy Aqueduct. It also sells water wholesale to 28 water districts; cities; and local agencies in Alameda, Santa Clara, and San Mateo counties. A total of approximately 250 taf is delivered and sold annually.

The CCWD delivers CVP water through the Contra Costa Canal. The source of the water can be Rock Slough, Mallard Slough, Old River, Sacramento River, or Victoria Canal. CCWD has a 40-year contract for 195 taf annually. Approximately 550,000 people receive the water; mostly in eastern Contra Costa County; but some people are in the San Joaquin River Hydrologic Region. CCWD also has its own water right to divert water from the Delta.

SCVWD serves 1.7 million people through the CVP's San Felipe Unit under a contract for 152,500 af annually. The keystone of the San Felipe Unit is San Luis Reservoir.

SWP water is conveyed via the SBA to SCVWD, Zone 7, and ACWD. The SBA is over 42 miles long from the South Bay pumping plant at Bethany Reservoir to the Santa Clara Terminal Facility. The SWP water is used in the South Bay for groundwater recharge; and for municipal, industrial, and agricultural purposes. See Figure SFB-20 for a graphical depiction of Bay Region water imports, as well as Sacramento and San Joaquin River inflows and Pacific Ocean outflow.

PLACEHOLDER Figure SFB-20 Water Imports to the San Francisco Bay Hydrologic Region

Regional Water Planning and Management

Integrated Regional Water Management Coordination and Planning

The San Francisco Bay Area IRWM Group identified five overarching regional goals in its updated IRWMP:

- Promote environmental, economic, and social sustainability
- Improve water supply reliability and quality
- Protect and improve watershed health and function and bay water quality
- Improve regional flood management
- Create, protect, enhance, and maintain environmental resources and habitats

The group further identified 35 objectives to achieve all of the regional goals. Three of the objectives address improving regional flood management:

- Reduce flood damage to homes, businesses, schools, and transportation infrastructure.
- Minimize risks to health, safety, and property by encouraging wise management and use of flood-prone areas.
- Identify and promote integrated flood management projects.

Integrated flood management involves integration among various agencies that traditionally have had conflicting goals and objectives. Integrated flood management projects maximize the flood management benefits from limited funding and other resources. More reliable funding is needed at all levels of government.

The water management issues facing the Bay Region will change over time as regulations become more stringent and environmental conditions change. New regional goals, objectives, and priorities may emerge. The Bay Area IRWM Group will review its IRWM Plan periodically, and adjust project sequencing to reflect any new regional priorities. This process of continuous review and update will optimize the effectiveness of the IRWM Plan.

Project Implementation

To achieve many of the goals and objectives of the updated Bay Area IRWMP, the group is proposing to implement 19 water enhancement projects with the help of $20 million in Proposition 84 Implementation Grant funding. The total cost of the projects, which are listed and described in Table SFB-19, is estimated to be approximately $56.5 million.

PLACEHOLDER Table SFB-19 Proposed Water Enhancement Projects, San Francisco Bay Hydrologic Region

Another initiative for the San Francisco Bay Area IRWM is additional data monitoring and coordination. The Bay Region has many water resources monitoring programs, but data gaps could be filled with additional data monitoring programs to understand and manage the region’s water resources better. Some potential new data monitoring programs are shown in Table SFB-20.

PLACEHOLDER Table SFB-20 Potential New Data Monitoring Programs, San Francisco Bay Hydrologic Region

Accomplishments

Ecosystem Restoration

One of the most significant long-term projects is the South Bay Salt Pond Restoration Project; a multi-year restoration of 15,100 acres of industrial salt ponds in Alameda and Santa Clara counties; and the largest wetland restoration project on the West Coast. Other bay wetland restoration projects include the Napa Sonoma Marsh, Bair Island, Sonoma Baylands, Hamilton-Bel Marin Keys, Cullinan Ranch, Sears Point Restoration, Bruener Marsh, and the Montezuma Wetland projects. In addition to providing increased habitat values, the restored wetlands may act as groundwater recharge areas, flood storage areas, and buffers to sea level rise.

Another significant restoration project is part of the Napa River Flood Control Project. The project includes the restoration of 659 acres of wetlands, 2 miles of lower Napa Creek, and 3.2 miles of floodplain and marsh plain terrace along the lower Napa River. The SFRWQCB has partnered with local, State, and federal agencies to restore an additional 4.5 miles of floodplain, riparian habitat, and fish habitat. Plans to restore the river from Oak Knoll Avenue to Oakville would extend the restored river corridor 13 miles upstream.

Challenges

Some major water challenges facing the Bay Region include providing reliable water supplies, especially during droughts and other emergency outages; maintaining or improving drinking water quality; protecting drinking water sources; improving the health of the San Francisco Bay ecosystem; linking local land use planning with water system planning; improving water management planning; managing floodplains amid urban development and high land costs; satisfying environmental water demands; and improving water quality in receiving waters. The impacts of climate change only complicate dealing with these challenges.

Flood Challenges

Recurring floods also are a major challenge. Lives, homes, businesses, farmlands, and infrastructure are frequently at risk. Some particularly vulnerable locations in the region are on the Guadalupe, Napa, and Petaluma rivers; and on Coyote and Corte Madera creeks. San Anselmo, Napa, and some communities in Santa Clara County are subject to frequent flooding. Levees are inadequate on tributaries of Alameda Creek, and railroad bridge openings are too small on major urban streams. Developed bay and coastal areas are vulnerable to sea level rise, tidal floods, and storm surges. Undesirable vegetation and beaver colonies in urban floodways pose additional challenges. Wildfires can denude steep erodible slopes in canyons and upland areas above urban development. The ensuing winter rains can flood developments with large debris flows, causing severe damage to structures and leaving large quantities of sediment and other detritus. Providing better protection for lives and property remains the definitive flood management challenge.

Effective flood preparedness is another challenge. It requires accurate evaluation of flood risk; adequate measures to mitigate flood damage; sufficient preparation for response and recovery; and effective coordination among local, State, and federal agencies. Completion of floodplain mapping, both the FEMA FIRMs and the complementary DWR Awareness Floodplain Mapping, will provide much needed information to evaluate flood risk. Mitigating flood damage may take many forms, including governmental regulation of construction and occupancy in flood-prone areas, flood-proofing, and structural protection such as levees. Response and recovery preparedness improves with the use of flood warning systems, and with formal agreements that specify agency responsibilities and funding. Successful coordination between local, State, and federal agencies enhances sharing of watershed resources, maintenance of streams, community awareness of local flood risks, sustainability of the Delta water supply, and protection of infrastructure from levee failure.

Local funding for flood management and for flood maintenance and construction projects has become less effective in recent years because of several factors:

- Increased protection of the environment has increased maintenance and construction costs.
- Concern for endangered species has hindered project scheduling.
- Environmental and endangered species permitting has been difficult to obtain.
- Measures to reduce taxes, especially property tax, have hindered raising sufficient revenue.
- Inflation has increased maintenance and construction costs.

Procuring adequate funding is difficult with these funding constraints. This lack of funding challenges flood managers to certify levees that meet FEMA or USACE standards, to assess the condition of flood control facilities, and to maintain or improve aging water infrastructure.

FloodSAFE is a strategic DWR initiative that seeks a sustainable integrated flood management and emergency response system throughout California to improve public safety; protect and enhance environmental and cultural resources; and support economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and reducing flood damages. FloodSAFE is guiding development of regional flood management plans. These plans will encourage regional cooperation in identifying and addressing flood hazards, and will include risk analyses, review of existing flood protection measures, and identification of potential projects and funding strategies. The plans will emphasize multiple objectives, system resiliency, and compatibility with State goals and IRWM plans.

The San Francisco Bay Area IRWM 2013 Plan states that sea level rise is expected to increase the risk of coastal erosion and flooding along the California coast, and higher water levels due to sea level rise could magnify the adverse impact of storm surges and high waves. Impacts to assets from extreme high tides in addition to net increases in sea level will likely result in increased inundation frequency, extents, and depths leading to catastrophic flooding and coastal erosion. Understanding the extent, depth, and duration of inundation and the patterns of erosion will be necessary for characterizing infrastructure vulnerability in coastal areas. The picture is further complicated by the concurrent vertical movement of the land due to tectonic activity. Projections of the relative sea level, the sum of both sea level rise and vertical land movement, are therefore important in the Bay Region.

Sea level rise will have a significant impact on the Bay Region. Water levels in San Francisco Bay have risen nearly 8 inches over the past century, and scientists agree that the rate of sea level rise is accelerating. While exact future increases in sea level rise are uncertain, scientists believe it is likely that the bay will rise 10 to 17 inches by 2050, 17 to 32 inches by 2070, and 31 to 69 inches at the end of the century. Between 1850 and 1960, about a third of the bay (240 square miles) was filled high enough to be above current sea level, but not above future sea level. Also, large portions of the South Bay are below current sea level. Studies show that 330 square miles of low-lying land around the bay may be vulnerable to sea level rise over the next century.

Present sea level rise projections suggest that global sea levels in the 21st century can be expected to be much higher than the recorded increase rise since 1854 of 7.6 inches. These projections are summarized in the State of California Sea-Level Rise Guidance Document (Ocean Protection Council 2013)

Conjunctive Management and Groundwater Storage

Conjunctive management, or conjunctive use, refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Managing both resources together, rather than in isolation, allows water managers to use the advantages of both resources for maximum benefit.

A survey undertaken in 2011-2012 jointly by DWR and ACWA to inventory and assess conjunctive management projects in California is summarized in Box SFB-5. More detailed information about the survey results and a statewide map of the conjunctive management projects and operational information, as of July 2012, is available online in *Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013*."

PLACEHOLDER SFB-5 Statewide Conjunctive Management Inventory Effort in California

Conjunctive Management Inventory Results

Of the 89 agencies or programs identified as operating a conjunctive management or groundwater recharge program in California, four are located in the San Francisco Bay Hydrologic Region. These four agencies have implemented various conjunctive management programs to optimize the use of groundwater and surface water resources. The earliest reported conjunctive use project in the region was in the 1920s by SCVWD. Zone 7 Water Agency began its conjunctive management program in 1962, followed by ACWD in 1996 and EBMUD in 2009. The responses to the conjunctive management survey from agencies in the region were incomplete. The information provided by each of the four agencies in the region is summarized below.

SCVWD operates multiple spreading basins for direct percolation of surface water in the Santa Clara Valley basin. The source of their recharge supplies includes water from the SWP, CVP, recycled water, and local surface water. Although capital costs to develop the projects were not reported, SCVWD indicated that operating costs of their conjunctive management program totaled approximately $3 million annually. One of the objectives of the conjunctive management survey was to gather information on the put-and-take capacity as well as the total storage capacity of the conjunctive management programs; unfortunately, this effort was largely unsuccessful due to a lack of response. SCVWD reported data for a single year (2010) — 104,000 af of water was used for local groundwater recharge programs and 52,000 af of water was banked with Semitropic Water Storage District in the Tulare Lake Hydrologic Region. According to the Bay Area IRWMP, SCVWD's integrated water system includes 10 reservoirs, 17 miles of canals, 4 water supply diversion dams, 300 acres of recharge ponds, and 91 miles of controlled in-stream recharge (Bay Area Integrated Regional Water Management Plan 2013).

Zone 7 Water Agency operates spreading basins for direct percolation into the Livermore Valley Basin using water from the SBA and from local sources. The groundw basin that Zone 7 Water Agency manages has a total capacity of 126,000 af. In addition to recharging local aquifers, Zone 7 Water Agency indicated that it had additional capacity with Semitropic Water Storage District (78,000 af) and Cawelo Water District (120,000 af) in Kern County for banking purposes.

ACWD reported that its groundwater-related programs in the Niles Cone Subbasin had an annual operating cost of $278,000; no capital costs were provided. The Bay Area IRWMP stated that ACWD used a series of former quarry pits to recharge groundwater; however, ACWD in response to the DWR/ACWA survey reported that it had a secured capacity of 150,000 af with Semitropic Water Storage District in Kern County.

EBMUD operates an aquifer storage and recovery (ASR) program in the East Bay Plain Subbasin as part of its Bayside Groundwater Project. The current project output of EBMUD's ASR program is variable, but the program has the capacity to inject up to 1 million gallons per day into a confined aquifer and make the same quantity available to customers during dry years.

None of the above agencies provided any information about project development cost, program goals and objectives, and constrains relative to the development of their respective conjunctive management or the groundwater banking programs.

Additional information regarding conjunctive management in California as well as discussion on associated benefits, costs, and issues can be found online from Update 2013, Volume 3, Chapter 9, "Conjunctive Management and Groundwater Storage."

Drought Planning

Many of the water suppliers in the Bay Region have urban water management plans, in accordance with the 1983 California Urban Water Management Planning Act. Suppliers such as SFPUC and EBMUD have urban water management plans, which contain strategies to address drought. These strategies include developing alternative dry-year water supply options, adopting water shortage allocation plans, and being prepared for catastrophic water supply interruptions.

Looking to the Future

Future Conditions

Future Scenarios

Update 2013 evaluates different ways of managing water in California depending on alternative future conditions and different regions of the state. The ultimate goal is to evaluate how different regional response packages, or combinations of resource management strategies from Volume 3, perform under alternative possible future conditions. The alternative future conditions are described as future scenarios. Together the response packages and future scenarios show what management options could provide for sustainability of resources and ways to manage uncertainty and risk at a regional level. The future scenarios are composed of factors related to future population growth and factors related to future climate change. Growth factors for the San Francisco Bay region are described below. Climate change factors are described in general terms in Chapter 5, Volume 1.

Water Conservation

The water plan scenario narratives include two types of water use conservation. The first is conservation that occurs without policy intervention (called background conservation). This includes upgrades in plumbing codes and end user actions such as purchases of new appliances and shifts to more water efficient landscape absent a specific government incentive. The second type of conservation expressed in the scenarios is through efficiency measures under continued implementation of existing best management practices in the Memorandum of Understanding (California Urban Water Conservation Council, 2004). These are specific measures that have been agreed upon by urban water users and are being implemented over time. Any other water conservation measures that require additional action on the part of water management agencies are not included in the scenarios, and would be represented as a water management response.

Growth Scenarios

Future water demand in the San Francisco Bay Hydrologic Region is affected by a number of growth and land use factors, such as population growth, planting decisions by farmers, and size and type of urban landscapes. See Table SFB-21 for a conceptual description of the growth scenarios used in the California Water Plan (CWP). The CWP quantifies several factors that together provide a description of future growth and how growth could affect water demand for the urban, agricultural, and environmental sectors in the San Francisco Bay region. Growth factors are varied between the scenarios to describe some of the uncertainty faced by water managers. For example, it is impossible to predict future population growth accurately, so the CWP uses three different, but plausible population growth estimates when determining future urban water demands. In addition, the CWP considers up to three different alternative views of future development density. Population growth and development density will reflect how large the urban landscape will become in 2050 and are used by the CWP to quantify encroachment into agricultural lands by 2050 in the San Francisco Bay region.

PLACEHOLDER Table SFB-21 Conceptual Growth Scenarios

For Update 2013, DWR worked with researchers at the University of California, Davis, to quantify how much growth might occur in the San Francisco Bay region through 2050. The UPlan model was used to estimate a year 2050 urban footprint under the scenarios of alternative population growth and development density (see http://ice.ucdavis.edu/project/uplan for information on the UPlan model). UPlan is a simple rule-based urban growth model intended for regional or county-level modeling. The needed space for each land use type is calculated from simple demographics and is assigned based on the net attractiveness of locations to that land use (based on user input), locations unsuitable for any development, and a general plan that determines where specific types of development are permitted. Table SFB-22 describes the amount of land devoted to urban use for 2006 and 2050, and the change in the urban footprint under each scenario. As shown in the table, the urban footprint grew by about 25 thousand acre under low population growth scenario (LOP) by 2050 relative to 2006 base-year footprint of about 680,000 acres. Although the San Francisco Bay region overall lost population under the low population growth scenario, the urban footprint still expanded because of areas of local growth. Urban footprint under high population scenario (HIP), however, grew by about 200,000 acres. The effect of varying housing density on the urban footprint is also shown.

PLACEHOLDER Table SFB-22 Growth Scenarios (Urban) – San Francisco Bay

Table SFB-23 describes how future urban growth could affect the land devoted to agriculture in 2050. Irrigated land area is the total agricultural footprint. Irrigated crop area is the cumulative area of agriculture, including multi-crop area, where more than one crop is planted and harvested each year. Each of the growth scenarios generally shows a decline in irrigated acreage over existing conditions, except under low population scenario. As shown in the table, irrigated crop acreage increases by about 5,000 acres by year 2050, while under high population growth the irrigated crop acreage declined as expected by about 15,000 acres.

PLACEHOLDER Table SFB-23 Growth Scenarios (Agriculture) – San Francisco Bay

San Francisco Bay 2050 Water Demands

In this section, a description is provided for how future water demands might change under scenarios organized around themes of growth and climate change described earlier in this chapter. The change in water demand from 2006 to 2050 is estimated for the San Francisco Bay region for the agriculture and urban sectors under 9 growth scenarios and 13 scenarios of future climate change. The climate change scenarios included the 12 Climate Action Team scenarios described in Chapter 5, Volume 1 and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a "without climate change" condition.

Figure SFB-21 shows the change in water demands for the urban and agricultural sectors under 9 growth scenarios, with variation shown across 13 climate scenarios. The nine growth scenarios include three alternative population growth projections and three alternative urban land development densities, as shown in Table SFB-21. The change in water demand is the difference between the historical average for 1998 to 2005 and future average for 2043 to 2050. Urban demand is the sum of indoor and outdoor water demand where indoor demand is assumed not to be affected by climate. Outdoor demand, however, depends on such climate factors as the amount of precipitation falling and the average air temperature. The solid blue dot in Figure SFB-21 represents the change in water demand under a repeat of historical climate, while the open circles represent change in water demand under 12 scenarios of future climate change.

PLACEHOLDER Figure SFB-21 Change in San Francisco Bay Agricultural and Urban Water Demands for 117 Scenarios from 2006-2050 (thousand acre-feet per year)

Urban demand increased under all high and current trend growth scenarios tracking with population growth, but it decreased under low population scenarios. Under the low population growth scenarios, the population is actually shown to drop in response to insufficient births and immigration relative to deaths. On average, water demand increased by about 780 taf under the three high population scenarios, 260 taf under the three current trend population scenarios and decreased by about 10 taf under low population scenarios when compared to historical average of about 1,070 taf. The results show change in future urban water demands are less sensitive to housing density assumptions or climate change than to assumptions about future population growth.

Agricultural water demand decreases under high and current trend population scenarios due to reduction in irrigated lands as a result of urbanization and background water conservation when compared with historical average water demand of about 120 taf. Under high population it decreased by 15 taf and under current trend population it decreased by about 2 taf. But under the three low population scenarios, the agricultural water demand actually increased in step with a modest increase in irrigated crop area. On average, for the three low population scenarios, this increase in water demand was about 5 taf.

Integrated Water Management Plan Summaries

Inclusion of the information contained in IRWMP's into the CWP Regional Reports has been a common suggestion by regional stakeholders at the Regional outreach meetings since the inception of the IRWM program. To this end the CWP has taken on the task of summarizing readily available Integrated Water Management Plan in a consistent format for each of the regional reports. This collection of information will not be used to determine IRWM grant eligibility. This effort is ongoing and will be included in the final CWP updates and will include up to 4 pages for each IRWMP in the regional reports.

In addition to these summaries being used in the regional reports we intend to provide all of the summary sheets in one IRWMP Summary "Atlas" as an article included in Volume 4. This atlas will, under one cover, provide an "at-a-glance" understanding of each IRWM region and highlight each region's key water management accomplishments and challenges. The atlas will showcase how the dedicated efforts of individual regional water management groups (RWMGs) have individually and cumulatively transformed water management in California.

All IRWMP's are different in how are organized and therefore finding and summarizing the content in a consistent way proved difficult. It became clear through these efforts that a process is needed to allow those with the most knowledge of the IRWMP's, those that were involved in the preparation, to have input on the summary. It is the intention that this process be initiated following release of the CWP Update 2013 and will continue to be part of the process of the update process for Update 2018. This process will also allow for continuous updating of the content of the atlas as new IRWMP's are released or existing IRWMP's are updated.

As can be seen in Figure SFB-22 there is one IRWM planning effort that is ongoing in the San Francisco Bay Hydrologic Region.

PLACEHOLDER Figure SFB-22 Integrated Regional Water Management Planning in San Francisco Bay Hydrologic Region

Placeholder Text: At the time of the Public Review Draft the collection of information out of the IRWMP's in the region has not been completed. Below are the basic types of information this effort will summarize and present in the final regional report for each IRWMP available. An opportunity will be provided to those with responsibility over the IRWMP to review these summaries before the reports are final.

Region Description: This section will provide a basic description of the IRWM region. This would include location, major watersheds within the region, status of planning activity, and the governance of the IRWM. In addition, a IRWM grant funding summary will be provided.

Key Challenges: The top five challenges identified by the IRWM would be listed in this section.

Principal Goals/Objective: The top five goals and objectives identified in the IRWMP will be listed in this section.

Major IRWM Milestones and Achievements: Major milestones (Top 5) and achievements identified in the IRWMP would be listed in this section.

Water Supply and Demand: A description (one paragraph) of the mix of water supply relied upon in the region along with the current and future water demands contained in the IRWMP will be provided in this section.

Flood Management: A short (one paragraph) description of the challenges faced by the region and any actions identified by the IRWMP will be provided in this section.

Water Quality: A general characterization of the water quality challenges (one paragraph) will be provided in this section. Any identified actions in the IRWMP will also be listed.

Groundwater Management: The extent and management of groundwater (one paragraph) as described in the IRWMP will be contained in this section.

Environmental Stewardship: Environmental stewardship efforts identified in the IRWMP will be summarized (one paragraph) in this section.

Climate Change: Vulnerabilities to climate change identified in the IRWMP will be summarized (one paragraph) in this section.

Tribal Communities: Involvement with tribal communities in the IRWM will be described (one paragraph) in this section of each IRWMP summary.

Disadvantaged Communities: A summary (one paragraph) of the discussions on disadvantaged communities contained in the IRWMP will be included in this section of each IRWMP summary.

Governance: This section will include a description (less than one paragraph) of the type of governance the IRWM is organized under.

Resource Management Strategies

Volume 3 contains detailed information on the various strategies which can be used by water managers to meet their goals and objectives. A review of the resource management strategies addressed in the available IRWMP's are summarized in Table SFB-24.

PLACEHOLDER Table SFB-24 Resource Management Strategies addressed in IRWMPs in the San Francisco Bay Hydrologic Region

Regional Resource Management Strategies

Bay Region water agencies have made significant investments since *California Water Plan Update 2009* in programs and projects that implement various resource management strategies. The 23 Bay Area Regional Priority Projects are examples of implementing resource management strategies such as Urban Runoff Management, Recycled Municipal Water, Ecosystem Restoration, Urban Water Use Efficiency, and Flood Risk Management. The projects are:

Urban Runoff Management

- San Pablo Spine & Regional Promotion of Green Infrastructure

- Hacienda Avenue "Green Street" Improvement
- Napa Valley Rainwater Harvesting

Recycled Municipal Water

- Central Contra Costa Sanitary District (CCCSD)/Concord Recycled Water Project (Phase I)
- Dublin San Ramon Service District (DSRSD) Central Dublin Recycled Water Distribution and Retrofit Project
- EBMUD East Bayshore Phase IA (I-80 Pipeline)
- MMWD Peacock Gap Recycled Water Extension
- North Bay Water Reuse Authority Program
  - Novato Sanitary District/North Marin Water District (NMWD) Novato North Service Area Project
  - Las Gallinas Valley Sanitary District (LGVSD)/NMWD Novato South Service Area Project
  - Napa Sanitation District Napa State Hospital Pipeline Construction Stage 1 Project
  - Sonoma Valley County Sanitation District (SVCSD) Recycled Water Stage 1 Project
- SFPUC Harding Park Recycled Water Project
- South Bay Water Recycling (SBWR) Industrial Expansion and Reliability

Urban Water Use Efficiency

- Regional Water Conservation Program

Ecosystem Restoration

- Sears Point Wetland and Watershed Restoration
- Bair Island Restoration
- Pond A16/17 Habitat Restoration

Flood Risk Management/Ecosystem Restoration

- Watershed Partnership Technical Assistance
- Stream Restoration with Schools and Community in Disadvantaged Communities of the North Bay
- Floodplain Mapping for the Bay Area with Disadvantaged Communities Focus
- Stormwater Improvements and Flood Reduction Strategies Pilot Project in Bay Point
- Disadvantaged Communities Richmond Shoreline and City of San Pablo Flood Project
- Pescadero Creek Watershed Disadvantaged Communities Integrated Flood Reduction and Habitat Enhancement Project
- Pescadero Creek Steelhead Smolt Outmigrant Trapping
- Stream Channel Shapes and Floodplain Restoration Guidance and Watershed Restoration in San Francisquito Creek; East Palo Alto, a Disadvantaged Community
- Steelhead and Coho: Bay Area Indicator for Restoration Success (S.F. Estuary Steelhead Monitoring Program)

Urban Runoff Management

The SFRWQCB, the San Francisco Estuary Project, municipal stormwater agencies, and other partners promote Low-Impact Development in the Bay Region. LID is a design approach that manages stormwater runoff to replicate pre-development hydrology. It promotes using natural on-site features to protect water quality and detain runoff.

Pollution Prevention

The SFRWQCB adopts TMDLs for Bay Region watersheds to limit pollutants that impair water quality (primarily sediments, pathogens, nutrients, mercury, polychlorinated biphenyls, and urban pesticides). The TMDLs are designed to help the region meet its goals of protecting and restoring waters, and improving watershed and habitat management by attaining water quality standards.

Climate Change

For over two decades, the State and federal governments have been preparing for climate change effects on natural and built systems with a strong emphasis on water supply. Climate change is already impacting many resource sectors in California, including water, transportation and energy infrastructure, public health, biodiversity, and agriculture (U.S. Global Change Research Program 2009; California Natural Resources Agency 2009). Climate model simulations based on the Intergovernmental Panel on Climate Change's 21st century scenarios project increasing temperatures in California, with greater increases in the summer. Projected changes in annual precipitation patterns in California will result in changes to surface runoff timing, volume, and type (Cayan 2008). Recently developed computer downscaling techniques indicate that California flood risks from warm-wet, atmospheric river type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011).

Currently, enough data exists to warrant the importance of contingency plans, mitigation (reduction) of GHG emissions, and incorporating adaptation strategies; methodologies and infrastructure improvements that benefit the region at present and into the future. While the State is taking aggressive action to mitigate climate change through GHG reduction and other measures (California Air Resources Board 2008), global impacts from carbon dioxide and other GHGs that are already in the atmosphere will continue to impact climate through the rest of the century (Intergovernmental Panel on Climate Change 2007).

Resilience to an uncertain future can be achieved by implementing adaptation measures sooner rather than later. Because of the economic, geographical, and biological diversity of California, vulnerabilities and risks from current and future anticipated changes are best assessed on a regional basis. Many resources are available to assist water managers and others in evaluating their region-specific vulnerabilities and identifying appropriate adaptive actions. (U.S. Environmental Protection Agency and California Department of Water Resources 2011; California Emergency Management Agency and California Natural Resources Agency 2012).

Observations

The region's observed temperature and precipitation vary greatly due to complex topography. Regionally specific temperature data can be retrieved through the Western Regional Climate Center (WRCC). The WRCC has temperature and precipitation data for the past century. Through an analysis of National Weather Service Cooperative Station and PRISM Climate Group gridded data, scientists from the WRCC have identified 11 distinct regions across the state for which stations located within a region vary with one another in a similar fashion. These 11 climate regions are used when describing climate trends within the state (Abatzoglou et al. 2009). DWR's hydrologic regions, however, do not correspond directly to

WRCC's climate regions. A particular hydrologic region may overlap more than one climate region and, hence, have different climate trends in different areas. For the purpose of this regional report, climate trends of the major overlapping climate regions are considered to be relevant trends for respective portions of the overlapping hydrologic region.

The Bay Region overlaps the WRCC Central Coast and Sacramento-Delta regions, and also small portions of the WRCC North Coast and North Central regions. Mean temperatures in the Central Coast Region have increased about 1.1-2.0 °F (0.6-1.1 °C), with minimum values increasing more than maximums [1.6-2.6 °F (0.9-1.4 °C) and 0.4-1.5 °F (0.2-0.8 °C), respectively]. Inland, temperatures in the Sacramento-Delta Region show a similar warming trend. A mean increase of 1.5-2.4 °F (0.8-1.3 °C) was recorded, with minimum temperatures increasing 2.1-3.1 °F (1.2-1.7 °C) and maximum temperatures increasing 0.7-1.9 °F (0.4-1.1 °C). Mean annual precipitation in Northern California has increased slightly in the 20th century, and precipitation patterns in the region have considerable geographic and annual variation (California Department of Water Resources 2006).

In the 20th century, tide gages and satellite altimetry show that global mean sea level has risen about 7 inches. The change in mean sea level at the San Francisco tide gage, the nation's oldest continually operating tidal observation station, is consistent with the global average of 7 inches. However, when the current rate is adjusted for vertical land motion and atmospheric pressure the relative mean sea level is increasing at a rate of 0.04 +/- 0.06 in yr-1 (1.02 +/- 1.73 mm yr-1) south of Cape Mendocino, which is lower than the current rate of global mean sea level rise (NAS 2012).

Projections and Impacts

While historical data is a measured indicator of how the climate is changing, it cannot project what future conditions may be like under different GHG emissions scenarios. Current climate science uses modeling methods to simulate and develop future climate projections. A recent study by Scripps Institution of Oceanography uses the most sophisticated methodology to date, and indicates by 2060-2069, temperatures will be 3.4 -4.9 °F (1.9 -2.7 °C) higher across the state than they were from 1985 to1994 (Pierce et al. 2012). In the Bay Region, the study projects that annual temperatures will increase 3.6-4.1 °F (2.0-2.3 °C), with a 2.9-3.1 °F (1.6-1.7 °C) increase in winter temperatures and a 4.1-5.2 °F (2.3-2.9 °C) increase in summer temperatures. Climate projections for the Bay Area from Cal-Adapt indicate that the temperatures between 1990 and 2100 will increase by as much as 4-5 °F (2.2-2.8 °C) in the winter and 5-6 °F (2.8-3.3 °C) in the summer (California Emergency Management Agency and California Natural Resources Agency 2012).

Changes in annual precipitation across California, either in timing or total amount, will result in changes in type of precipitation (rain or snow) in a given area, and in surface runoff timing and volume. Most climate model precipitation projections for the state anticipate drier conditions in Southern California, with heavier and warmer winter precipitation in Northern California. More intense wet and dry periods are anticipated, which could lead to flooding in some years and drought in others. In addition, extreme precipitation events are projected to increase with climate change (Pierce et al. 2012). Since there is less scientific detail on localized precipitation changes, there is a need to adapt to this uncertainty at the regional level (Qian et al. 2010).

Given these projections, climate change is anticipated to present significant water resource management challenges to the Bay Region. Approximately 70 percent of the region's water supply is imported, and the majority of the imported water originates in the Sierra Nevada. The Sierra Nevada snowpack is expected to continue to decline as warmer temperatures raise snow levels, reduce spring snowmelt, and increase winter runoff; reducing water supplies for over 7 million people and agriculture in the region. The Sierra Nevada is projected to experience a 48 to 65 percent reduction of its historical average snowpack by the end of this century (van Vuuren et al. 2011).

Coastal observations and global model projections indicate that the California coast and estuaries will experience increasing mean sea levels during the next century, which will significantly affect development and infrastructure in the Bay Region. Mean sea levels are projected to rise 5 to 24 inches (12-61cm) by 2050 and 17 to 66 inches (42-167 cm) by 2100 (National Research Council 2012). A 55-inch rise in mean sea level would place an estimated 270,000 people in the Bay Area at risk from flooding; 98 percent more than are currently at risk; and put an estimated $62 billion worth of shoreline development at risk; including major transportation infrastructure such as rail lines, freeways, and airports (Bay Conservation and Development Commission 2011). Also, the expected increase in both the intensity and frequency of storms will increase the risk of flooding in the Bay Region, from both larger storm surges and greater stream runoff.

Climate changes also are expected to substantially alter the Bay ecosystem. Wetland and transitional habitats will be vulnerable to inundation, erosion, and changes in sediment supply. The highly developed shoreline will constrain the ability of these habitats to migrate landward (Bay Conservation and Development Commission 2011). These habitat changes, along with changes to freshwater inflow and water quality, will impact the species composition in the Bay.

Adaptation

Climate change has the potential to impact the region, which the state depends upon for its economic and environmental benefits. These changes will increase the vulnerability of natural and built systems in the region. Impacts to natural systems will challenge aquatic and terrestrial species with diminished water quantity and quality, and shifting eco-regions. Built systems will be impacted by changing hydrology and runoff timing, loss of natural snowpack storage, making the region more dependent on surface storage in reservoirs and groundwater sources. Increased future water demand for both natural and built systems may be particularly challenging with less natural storage and less overall supply.

Water managers and local agencies must work together to determine the appropriate planning approach for their operations and communities. While climate change adds another layer of uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (U.S. Environmental Protection Agency and California Department of Water Resources 2011). However, stationarity (the idea that natural systems fluctuate within an unchanging envelope of variability) can no longer be assumed, so new approaches will likely be required (Milly et.al. 2008)

IRWM planning is a framework that allows water managers to address climate change on a smaller, more regional scale. Climate change now is a required component of all IRWM plans (California Department of Water Resources 2010). IRWM regions must identify and prioritize their specific vulnerabilities to climate change, and identify the adaptation strategies that are most appropriate. Planning and adaptation strategies that address the vulnerabilities should be proactive and flexible, starting with proven strategies that will benefit the region today, and adding new strategies that will be resilient to the uncertainty of climate change.

Local agencies, as well as federal and State agencies, face the challenge of interpreting climate change data and determining which methods and approaches are appropriate for their planning needs. The Climate Change Handbook for Regional Water Planning (U.S. Environmental Protection Agency and California Department of Water Resources 2011) provides an analytical framework for incorporating climate change impacts into a regional and watershed planning process, and considers adaptation to climate change. The handbook provides guidance for assessing the vulnerabilities of California's watersheds and regions to climate change impacts, and prioritizing these vulnerabilities.

Numerous efforts in the Bay Region are addressing climate change. Two recent policy efforts include the BCDC Climate Change Bay Plan Amendment, and the California Coastal Conservancy Climate Change Policy and Project Selection Criteria. Planning efforts in the region include the Bay Area IRWM Plan Update; the San Francisco Estuary Institute (SFEI) *Baylands Ecosystem Habitat Goals Climate Change Technical Update*; and the Plan Bay Area Project, which links land-use and transportation planning in the region. Numerous studies and pilot projects also are under way, including Adapting to Rising Tides, Our Coast Our Future, San Francisco Living Shoreline, San Francisco Estuary Pilot, and the Innovative Wetland Adaptive Techniques in Lower Madera Creek Project. Collaborative groups such as the Bay Area Ecosystem Climate Change Consortium, the North Bay Climate Adaptation Initiative, and the San Francisco Conservations Commons also are working to bring together technical experts, scientists, natural resource managers, and policymakers to better understand and address the impacts of climate change on Bay Area ecosystems and communities.

The Bay Region contains a diverse landscape with different climate zones, which makes finding one adaptation strategy that works throughout the region difficult. Water managers and local agencies must work together to determine the appropriate adaptation strategy and planning approach for their community. Whatever approach is used, water managers and communities must implement adaptation measures sooner rather than later to be prepared for an uncertain future.

The State of California has developed additional tools and resources to assist resource managers and local agencies in adapting to climate change, including:

- California Climate Adaptation Strategy (2009) — California Natural Resources Agency (CNRA) at: http://www.climatechange.ca.gov/adaptation/strategy/index.html
- California Climate Adaptation Planning Guide (2012) — California Emergency Management Agency (Cal EMA) and CNRA at: http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html
- Cal-Adapt Web site at: http://cal-adapt.org/
- Urban Forest Management Plan (UFMP) Toolkit — sponsored by the California Department of Forestry and Fire Management at: http://ufmptoolkit.com/
- California Climate Change Portal at: http://www.climatechange.ca.gov/
- DWR Climate Change Web site at: http://www.water.ca.gov/climatechange/resources.cfm
- The Governor's Office of Planning and Research (OPR) Web site at: http://www.opr.ca.gov/m_climatechange.php

Many of the resource management strategies found in Volume 3 not only assist in meeting water management objectives, but also provide benefits for adapting to climate change. These strategies include:

- Agricultural and Urban Water Use Efficiency
- Conveyance – Regional/Local
- System Reoperation
- Desalination
- Recycled Municipal Water
- Surface Storage – Regional/Local
- Pollution Prevention
- Agricultural Lands Stewardship
- Ecosystem Restoration
- Land-Use Planning and Management
- Watershed Management
- Integrated Flood Management

The myriad of resources and choices available to water managers can seem overwhelming. However, managers can implement many proven strategies to prepare for climate change in the Bay Region, regardless of the magnitude of future warming. These strategies often provide multiple benefits. For example; developing “living shorelines”, an approach that integrates subtidal habitat restoration with adjacent tidal and riparian areas to benefit multiple species, can also improve water quality; increase wave attenuation; and reduce shoreline erosion and flooding. Other adaptation measures include water use efficiency, wetland restoration, coastal armoring, elevating development, floating development, and in some cases, managed retreat.

Water managers need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystems, which can benefit humans by carbon sequestration, pollution remediation, and flood risk reduction. Increased collaboration between water managers, land-use planners, and ecosystem managers can identify common goals and actions that are needed to achieve resilience to climate change and other stressors.

Mitigation

California’s water sector has a large energy footprint, consuming 7.7 percent of statewide electricity (California Public Utilities Commission 2010). Energy is used in the water sector to extract, convey, treat, distribute, use, condition, and dispose of water. Figure 3-26, Water-Energy Connection in Volume 1, CA Water Today shows all of the connections between water and energy in the water sector; both water use for energy generation and energy use for water supply activities. The regional reports in Update 2013 are the first to provide detailed information on the water-energy connection, including energy intensity (EI) information at the regional level. This EI information is designed to help inform the public and water utility managers about the relative energy requirements of the major water supplies used to meet demand. Since energy usage is related to GHG emissions, this information can support measures to reduce GHG’s, as mandated by the State.

Figure SFB-23 shows the amount of energy associated with the extraction and conveyance of one acre-foot of water for each of the major sources in this region. The quantity used is also included, as a percent. For reference, Figure 3-26, Water-Energy Connection in CA Water Today, Volume 1 highlights which water-energy connections are illustrated in Figure SFB-23; only extraction and conveyance of raw water. Energy required for water treatment, distribution, and end uses of the water are not included. Not all water types are available in this region. Some water types flow by gravity to the delivery location and therefore do not require any energy to extract or convey (represented by a white light bulb).

PLACEHOLDER Figure SFB-23 Energy Intensity of Raw Water Extraction and Conveyance in the San Francisco Bay Hydrologic Region

Recycled water and water from desalination used within the region are not show in Figure SFB-23 because their energy intensity differs in important ways from those water sources. The energy intensity of both recycled and desalinated water depend not on regional factors but rather on much more localized, site, and application specific factors. Additionally, the water produced from recycling and desalination is typically of much higher quality than the raw (untreated) water supplies evaluated in Figure SFB-23. For these reasons, discussion of energy intensity of desalinated water and recycled water are included in Volume 3, Resource Management Strategies.

Energy intensity, sometimes also known as embedded energy, is the amount of energy needed to extract and convey an acre-foot of water from its source (e.g. groundwater or a river) to a delivery location, such as a water treatment plant or a SWP delivery turnout. (Extraction refers to the process of moving water from its source to the ground surface. Many water sources are already at ground surface and require no energy for extraction, while others like groundwater or seawater for desalination require energy to move the water to the surface. Conveyance refers to the process of moving water from a location at the ground surface to a different location, typically but not always a water treatment facility. Conveyance can include pumping of water up hills and mountains or can occur by gravity). EI should not be confused with total energy—that is, the amount of energy (e.g. kWh) required to deliver all of the water from a water source to customers within the region. EI focuses not on the total amount of energy used to deliver water, but rather the energy required to deliver a single unit of water (in kWh/acre-foot). In this way, energy intensity gives a normalized metric which can be used to compare alternative water sources.

In most cases, this information will not be of sufficient detail for actual project level analysis. However, these generalized, region-specific metrics provide a range in which energy requirements fall. The information can also be used in more detailed evaluations using tools such as WeSim (http://www.pacinst.org/publication/wesim/) that allows modeling of water systems to simulate outcomes for energy, emissions, and other aspects of water supply selection. It's important to note that water supply planning must take into consideration a myriad of different factors in addition to energy impacts: costs, water quality, opportunity costs, environmental impacts, reliability, and other many other factors.

EI is closely related to GHG emissions, but not identical, depending on the type of energy used (see *California Water Today*, *Water-Energy*, *Volume 1*). In California, generation of one megawatt-hour (MWh) of electricity results in the emission of about a third of a metric ton of GHG, typically referred to as carbon dioxide equivalent or CO_2e (eGrid 2012). This estimate takes into account the use of GHG-free hydroelectricity, wind, and solar and fossil fuel sources like natural gas and coal. The GHG emissions from a specific electricity source may be higher or lower than this estimate.

Reducing GHG emissions is a State mandate. Water managers can support this effort by considering EI factors, such as those presented here, in their decision-making process. Water use efficiency and related best management practices can also reduce GHGs (See *Volume 3, Resource Management Strategies*).

Accounting for Hydroelectric Energy

Generation of hydroelectricity is an integral part of many of the state's large water projects. In 2007, hydroelectric generation accounted for nearly 15 percent of all electricity generation in California. The SWP, CVP, Los Angeles Aqueduct, Mokelumne Aqueduct, and Hetch Hetchy Aqueducts all generate large amounts of hydroelectricity at large multi-purpose reservoirs at the heads of each system. In addition to hydroelectricity generation at head reservoirs, several of these systems also generate hydroelectric energy by capturing the power of water falling through pipelines at in-conduit generating facilities. (In-conduit generating facilities refer to hydroelectric turbines that are placed along pipelines to capture energy as water runs downhill in a pipeline [conduit].) Hydroelectricity is also generated at hundreds of smaller reservoirs and run-of-the-river turbine facilities.

Hydroelectric generating facilities at reservoirs provide unique benefits. Reservoirs like the SWP's Oroville Reservoir are operated to build up water storage at night when demand for electricity is low, and release the water during the daytime hours when demand for electricity is high. This operation, common to many of the state's hydropower reservoirs, helps improve energy grid stabilization and reliability and reduces GHG emissions by displacing the least efficient electricity generating facilities. Hydroelectric facilities are also extremely effective for providing back-up power supplies for intermittent renewable resources like solar and wind power. Because the sun can unexpectedly go behind a cloud or the wind can die down, intermittent renewables need back up power sources that can quickly ramp up or ramp down depending on grid demands and generation at renewable power installations.

Despite these unique benefits and the fact that hydroelectric generation was a key component in the formulation and approval of many of California's water systems, accounting for hydroelectric generation in EI calculations is complex. In some systems like the SWP and CVP, water generates electricity and then flows back into the natural river channel after passing through the turbines. In other systems like the Mokelumne aqueduct, water can leave the reservoir by two distinct outflows, one that generates electricity and flows back into the natural river channel and one that does not generate electricity and flows into a pipeline flowing into the EBMUD service area. In both these situations, experts have argued that hydroelectricity should be excluded from EI calculations because the energy generation system and the water delivery system are in essence separate (Wilkinson 2000).

DWR has adopted this convention for the EI for hydropower in the regional reports. All hydroelectric generation at head reservoirs has been excluded from Figure SFB-22. Consistent with Wilkinson (2000) and others, DWR has included in-conduit and other hydroelectric generation that occurs as a consequence of water deliveries, such as the Los Angeles Aqueduct's hydroelectric generation at San Francisquito, San Fernando, Foothill and other power plants on the system (downstream of the Owen's River Diversion Gates). DWR has made one modification to this methodology to simplify the display of results: EI has been calculated at each main delivery point in the systems; if the hydroelectric generation in the conveyance system exceeds the energy needed for extraction and conveyance, the EI is reported as zero (0). That is, no water system is reported as a net producer of electricity, even though several systems do produce more electricity in the conveyance system than is used (e.g., Los Angeles Aqueduct, Hetch Hetchy Aqueduct).(*For detailed descriptions of the methodology used for the water types presented, see Technical Guide, Volume 5*).

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Table SFB-1 Water Governance, San Francisco Bay Hydrologic Region

Local Water Supply Agencies
Alameda County Water District, Contra Costa Water District, East Bay Municipal Utility District, Marin Municipal Water District, City of Napa, San Francisco Public Utilities Commission, Santa Clara Valley Water District, Solano County Water Agency, Sonoma County Water Agency, Zone 7 Water Agency, Hetch Hetchy Water and Power
Local Wastewater Management Agencies
Fairfield-Suisun Sewer District, Napa Sanitation District, North San Mateo Sanitation District, Novato Sanitary District, San Mateo County, Sausalito/Marin City Sanitary District, Sewage Agency of Southern Marin, Stege Sanitary District, Town of Yountville, Vallejo Sanitation & Flood Control District, West Bay Sanitary District
State Government Agencies
California Department of Water Resources, State Water Resources Control Board, San Francisco Regional Water Quality Control Board, California Department of Public Health, California Division of Safety of Dams, California Department of Fish and Wildlife, State Coastal Conservancy, California Environmental Protection Agency, Bay Conservation and Development Commission
Federal Government Agencies
Bureau of Reclamation, Federal Energy Regulatory Commission, United States Environmental Protection Agency, United States Army Corps of Engineers, National Oceanic and Atmospheric Administration Fisheries, United States Fish and Wildlife Service

Table SFB-2 Alluvial Groundwater Basins and Subbasins within the San Francisco Bay Hydrologic Region

Basin/Subbasin		Basin Name
2-1		Petaluma Valley
2-2		Napa-Sonoma Valley
	2-2.01	Napa Valley
	2-2.02	Sonoma Valley
	2-2.03	Napa-Sonoma Lowlands
2-3		Suisun-Fairfield Valley
2-4		Pittsburg Plain
2-5		Clayton Valley
2-6		Ygnacio Valley
2-7		San Ramon Valley
2-8		Castro Valley
2-9		Santa Clara Valley
	2-9.01	Niles Cone
	2-9.02	Santa Clara
	2-9.03	San Mateo Plain
	2-9.04	East Bay Plain
2-10		Livermore Valley
2-11		Sunol Valley
2-19		Kenwood Valley
2-22		Half Moon Bay Terrace
2-24		San Gregorio Valley
2-26		Pescadero Valley
2-27		Sand Point Area
2-28		Ross Valley
2-29		San Rafael Valley
2-30		Novato Valley
2-31		Arroyo Del Hambre Valley
2-32		Visitacion Valley
2-33		Islais Valley
2-35		Westside
2-36		San Pedro Valley
2-37		South San Francisco
2-38		Lobos
2-39		Marina
2-40		Downtown San Francisco

Table SFB-3 Number of Well Logs by County and Use for the San Francisco Bay Hydrologic Region (1977-2010)

County	Total Number of Well Logs by Well Use						
	Domestic	**Irrigation**	**Public Supply**	**Industrial**	**Monitoring**	**Other**	**Total Well Records**
Napa	3,141	1,267	90	30	492	149	5,169
Marin	867	249	33	12	748	121	2,030
Alameda	650	251	45	37	11,972	2,154	15,109
San Francisco	3	9	7	5	1,221	300	1,545
Santa Clara	2,918	356	145	62	24,522	6,187	34,190
San Mateo	1,372	462	36	8	2,532	488	4,898
Total Well Records	8,951	2,594	356	154	41,487	9,399	62,941

Table SFB-4 CASGEM Groundwater Basin Prioritization for the San Francisco Bay Hydrologic Region

Basin Prioritization	Count	Basin/Subbasin Number	Basin Name	Subbasin Name	2010 Census Population
High	1	2-9.02	SANTA CLARA VALLEY	SANTA CLARA	1,633,190
Medium	1	2-2.01	NAPA-SONOMA VALLEY	NAPA VALLEY	91,234
Medium	2	2-10	LIVERMORE VALLEY		196,658
Medium	3	2-1	PETALUMA VALLEY		49,915
Medium	4	2-9.01	SANTA CLARA VALLEY	NILES CONE	321,494
Medium	5	2-2.02	NAPA-SONOMA VALLEY	SONOMA VALLEY	31,275
Medium	6	2-9.04	SANTA CLARA VALLEY	EAST BAY PLAIN	881,718
Low	1	2-2.03	NAPA-SONOMA VALLEY	NAPA-SONOMA LOWLANDS	58,367
Very Low	25	See *Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013"*			
Totals:	**33**			**Population of GW Basin Area:**	**5,075,243**

Table SFB-5 Groundwater Level Monitoring Wells by Monitoring Entity in the San Francisco Bay Hydrologic Region

State and Federal Agencies	Number of Wells
USGS	6
Total State and Federal Wells:	**6**
Monitoring Cooperators	**Number of Wells**
Napa County Flood Control and Water Conservation District	12
Total Cooperator Wells:	**12**
CASGEM Monitoring Entities	**Number of Wells**
Alameda County Water District	26
City of Pittsburg	9
Coastside County Water District	1
County of Napa [NOT YET DESIGNATED]	14
Montara Water and Sanitary District	6
San Francisco Public Utilities Commission	16
Sonoma County Water Agency	26
Total CASGEM Monitoring Entities:	**98**
Grand Total:	**116**

Note: Additional CASGEM Monitoring Entities in the San Francisco Bay Hydrologic Region include: South Westside Basin Voluntary Cooperative Groundwater Monitoring Association (7 wells); Sonoma County Permit and Resource Management District (76 wells); Santa Clara Valley Water District (XX wells); Zone 7 Water Agency (XX wells).

Table SFB-6 Sources of Groundwater Quality Information

Agency	Links to Information
State Water Resources Control Board	Groundwater • Communities that Rely on a Contaminated Groundwater Source for Drinking Water • Nitrate in Groundwater: Pilot Projects in Tulare Lake Basin/Salinas Valley • Hydrogeologically Vulnerable Areas • Aquifer Storage and Recovery • Central Valley Salinity Alternatives for Long-Term Sustainability (CV-Salts) GAMA • GeoTracker GAMA (Monitoring Data) • Domestic Well Project • Priority Basin Project • Special Studies Project • California Aquifer Susceptibility Project Contaminant Sites • Land Disposal Program • Department of Defense Program • Underground Storage Tank Program • Brownfields
California Department of Public Health	Division of Drinking Water and Environmental Management • Drinking Water Source Assessment and Protection (DWSAP) Program • Chemicals and Contaminants in Drinking Water • Chromium-6 • Groundwater Replenishment with Recycled Water
Department of Water Resources	Groundwater Information Center • Bulletin 118 Groundwater Basins • California Statewide Groundwater Elevation Monitoring (CASGEM) • Groundwater Level Monitoring • Groundwater Quality Monitoring • Well Construction Standards • Well Completion Reports
Department of Toxic Substances Control	• EnviroStor
Department of Pesticide Regulation	Groundwater Protection Program • Well Sampling Database • Groundwater Protection Area Maps
U.S. Environmental Protection Agency	US EPA STORET Environmental Data System
United States Geological Survey	USGS Water Data for the Nation

Table SFB-7 Sources of Imported Surface Water, San Francisco Bay Hydrologic Region

Water Conveyance Facility	Water Source	Operator	Counties Served	Water Supplied to the Bay Region via Facility in 2010 (acre-feet)
San Felipe Unit of CVP	Delta via San Luis Reservoir	USBR (CVP)	Santa Clara and San Benito Counties	42,100 (6%)
Sonoma and Petaluma Aqueducts	Russian River	SCWA	Sonoma and Marin Counties	19,300 (3%)
North Bay Aqueduct - SWP	Northern Delta	DWR (SWP)	Solano and Napa Counties	31,300 (4%)
Putah South Canal	Lake Berryessa	USBR	Solano County	34,500 (5%)
Contra Costa Canal	Western Delta	CCWD (CVP)	Contra Costa County	54,100 (8%)
South Bay Aqueduct - SWP	Delta	DWR (SWP)	Alameda and Santa Clara Counties	133,900 (19%)
South Bay Aqueduct - SWP	Wheeled	DWR (SWP)	Alameda County	15,000 (2%)
Mokelumne Aqueduct	Mokelumne River	EBMUD	Alameda and Contra Costa Counties	159,000 (22%)[1]
Hetch Hetchy Aqueduct	Tuolumne River	SFPUC	San Francisco, San Mateo, Alameda, and Santa Clara Counties	218,000 (31%)[1]

Note:

[1] Volume does not include storage change at reservoirs along conveyance facility.

Table SFB-8 San Francisco Bay Hydrologic Region Average Annual Groundwater Supply by Planning Area (PA) and by Type of Use (2005-2010)

San Francisco Bay Hydrologic Region		Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
PA Number	PA Name	TAF[1]	%[2]	TAF[1]	%[2]	TAF[1]	%[2]	TAF[1]	%[2]
201	North Bay	54.7	71%	23.8	16%	0.0	0%	78.6	34%
202	South Bay	21.4	85%	159.6	16%	0.0	0%	181.0	18%
2005-10 Annual Average HR Total:		**76.1**	**74%**	**183.5**	**16%**	**0.0**	**0%**	**259.5**	**21%**

Notes:

1 TAF = thousand acre-feet

2 Percent use is the percent of the total water supply that is met by groundwater, by type of use.

Table SFB-9 San Francisco Bay Hydrologic Region Average Annual Groundwater Supply by County and by Type of Use (2005-2010)

San Francisco Bay Hydrologic Region	Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
County	**TAF[1]**	**%[2]**	**TAF[1]**	**%[2]**	**TAF[1]**	**%[2]**	**TAF[1]**	**%[2]**
Napa	36.6	77%	7.4	29%	0.0	0%	44.0	59%
Marin	3.1	63%	1.0	2%	0.0	0%	4.0	9%
Alameda	5.8	52%	35.9	16%	0.0	0%	41.7	17%
San Francisco	0.0	0%	0.1	0%	0.0	0%	0.1	0%
Santa Clara	34.1	49%	133.7	31%	0.0	0%	167.7	34%
San Mateo	2.0	67%	8.5	8%	0.0	0%	10.5	9%
2005-10[3] Annual Ave. Total:	**81.5**	**60%**	**186.4**	**21%**	**0.0**	**0%**	**268.0**	**26%**

Notes:

[1] TAF = thousand acre-feet

[2] Percent use is the percent of the total water supply that is met by groundwater, by type of use.

[3] 2005-10 precipitation equals 99 percent of the 30-year average for the San Francisco Bay region.

Table SFB-10 Community Drinking Water Systems, San Francisco Bay Hydrologic Region

Community Drinking Water System	Number	Percent	Population Served[3]	Percent of Population Served
Large (> 10,000 people)	54	28	6,381,090	98.3
Medium (3,301 to 10,000 people)	7	4	48,619	0.7
Small (500 to 3,300 people)	27	14	49,051	0.8
Very Small (< 500 people)	96	51	12,484	0.2
Wholesale	6	3	-	-
Total	190	100	6,491,244	100

Notes:

Sonoma County Water Agency's system is in both the North Coast and Bay regions. It is counted only in the North Coast region to avoid duplicative counting.

The City of Morgan Hill's system is in both the Central Coast and Bay regions. It is counted only in the Central Coast region to avoid duplicative counting.

Population estimates for community drinking water systems are from the CDPH PICME database and include transient persons (i.e., visitors).

Table SFB-11 Francisco Bay Hydrologic Region Water Balance Summary for 2001-2010

Table SF-X San Francisco Hydrologic Region water balance for 2001-2010 (in TAF)

San Francisco (TAF)	Water Year (Percent of Normal Precipitation)									
	2001 (81%)	2002 (98%)	2003 (89%)	2004 (98%)	2005 (129%)	2006 (129%)	2007 (56%)	2008 (72%)	2009 (72%)	2010 (101%)
Water Entering the Region										
Precipitation	4,908	6,061	5,539	6,072	8,047	8,581	3,696	4,782	4,789	6,736
Inflow from Oregon/Mexico	0	0	0	0	0	0	0	0	0	0
Inflow from Colorado River	0	0	0	0	0	0	0	0	0	0
Imports from Other Regions	872	950	1,157	1,163	1,175	1,473	1,097	1,023	1,227	1,157
Total	**5,780**	**7,011**	**6,696**	**7,235**	**9,222**	**10,054**	**4,793**	**5,805**	**6,016**	**7,893**
Water Leaving the Region										
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	415	450	411	454	395	470	470	447	472	369
Outflow to Oregon/Nevada/Mexico	0	0	0	0	0	0	0	0	0	0
Exports to Other Regions	0	0	0	0	0	0	0	0	0	0
Statutory Required Outflow to Salt Sink	20	787	651	739	1,444	1,468	582	567	404	512
Additional Outflow to Salt Sink	759	683	714	520	569	550	600	513	529	437
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	4,795	5,041	4,812	5,406	6,636	7,205	3,397	4,346	4,666	6,459
Total	**5,989**	**6,961**	**6,588**	**7,119**	**9,044**	**9,693**	**5,049**	**5,872**	**6,070**	**7,777**
Change in Supply										
[+] Water added to storage [-] Water removed from storage										
Surface Reservoirs	-56	-37	40	-39	52	418	-179	-8	-99	81
Groundwater **	-153	86	69	155	127	-57	-77	-59	45	35
Total	**-209**	**49**	**109**	**116**	**179**	**361**	**-256**	**-67**	**-54**	**116**
Applied Water * (Ag, Urban, Wetlands) (compare with Consumptive Use)	1,214	1,285	1,234	1,240	1,180	1,184	1,231	1,194	1,279	1,049

* Definition: Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

** Definition: Change in Supply: Groundwater – The difference between water extracted from and water recharged into groundwater basins in a region. All regions and years were calculated using the following equation:

change in supply: groundwater = intentional recharge + deep percolation of applied water + conveyance deep percolation and seepage - withdrawals

This equation does not include unknown factors such as natural recharge and subsurface inflow and outflow. For further details, refer to Volume 4, Reference Guide – *California's Groundwater Update 2013* and Volume 5 Technical Guide.

n/a = not applicable

Table SFB-12 Flood Management Agencies, San Francisco Bay Hydrologic Region

	Structural Approaches						Land Use Management								Preparedness, Response, and Recovery										
	Flood Projects						Flood Plains			Flood Insurance			Regu-lation		Data Manage-ment				Event Management						
	Financing	Development	Construction	Operation	Encroachment	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated flood ways	Data collection	Hydrologic	Data station	Flood education	Preparedness	Response	Response	System	Recovery funding	Recovery	Mitigation
Federal agencies																									
Federal Emergency Management Agency										☐		☐											☐		☐
National Weather Service															☐	☐	☐	☐	☐	☐	☐				
Natural Resources Conservation Service	☐	☐	☐															☐							
U.S. Geological Survey															☐	☐	☐								
U.S. Army Corps of Engineers	☐	☐	☐	☐	☐	☐									☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
State agencies																									
California Conservation Corps																				☐	☐				
Department of Corrections																					☐				
Department of Forestry and Fire Protection																				☐					
Department of Water Resources	☐	☐	☐	☐	☐	☐			☐	☐		☐			☐	☐	☐	☐	☐	☐	☐		☐	☐	
Office of Emergency Services																			☐	☐	☐	☐	☐		☐

	Structural Approaches						Land Use Management								Preparedness, Response, and Recovery										
	Flood Projects						Flood Plains			Flood Insurance			Regu-lation		Data Manage-ment			Event Management							
	Financing	Development	Construction	Operation	Encroachment	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated flood ways	Data collection	Hydrologic	Data station	Flood education	Preparedness	Response	Response	System	Recovery funding	Recovery	Mitigation
Local agencies																									
County and city emergency services units																			☐	☐	☐				
County and city planning departments														☐											
County and city building departments													☐												
Local conservation corps																				☐	☐				
Local initial responders to emergencies																			☐	☐	☐				
Alameda County FCWCD	☐	☐			☐	☐																			
Contra Costa County FCWCD	☐	☐			☐	☐									☐	☐	☐								
Marin County FCWCD	☐	☐			☐	☐									☐		☐								
Napa County FCWCD	☐	☐	☐	☐	☐	☐																			
San Francisco Department of Public Works																		☐	☐						
San Francisquito Creek Joint Powers Authority	☐	☐																							
San Mateo County Flood Control District	☐																								

	Structural Approaches						Land Use Management									Preparedness, Response, and Recovery										
	Flood Projects						Flood Plains			Flood Insurance			Regu-lation			Data Manage-ment				Event Management						
	Financing	Development	Construction	Operation	Encroachment	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated flood ways		Data collection	Hydrologic	Data station	Flood education	Preparedness	Response	Response	System	Recovery funding	Recovery	Mitigation
Santa Clara Valley Water Agency	☐	☐	☐	☐	☐	☐	☐	☐			☐								☐	☐	☐	☐				
Sonoma County Water Agency	☐	☐	☐	☐	☐	☐													☐							
Zone 7 Water Agency	☐	☐	☐	☐	☐	☐													☐							

Note: FCWCD=Flood Control and Water Conservation District

Table SFB-13 Flood Control Facilities, San Francisco Bay Hydrologic Region

Facility	Stream	Owner (Sponsor)	Description	Protects
Reservoirs and lakes				
L. Chesbro	Llagas Cr.	Santa Clara Valley WD	3 taf flood control	San Jose
L. Del Valle	Arroyo Valle	DWR	38 taf flood control	Pleasanton, Fremont, Niles, Union City
Cull Cr.	Cull Cr.	Alameda Co. FCWCD (NRCS)	310 AF flood control	Castro Valley
Non-storage flood control facilities				
Alameda Cr.	Alameda Cr.	USACE	Channel Improvement	Livermore Valley, Niles Canyon, coastal plain
Emeryville Marina—Point Park	San Francisco Bay	USACE	Bank protection	Emeryville
Fairfield Streams	Ledgewood Cr., Laurel Cr., McCoy Cr., Pennsylvania Ave. Cr., Union Ave. Cr.	USACE	Channel enlargement, creek diversion	Fairfield and vicinity
San Lorenzo Cr.	San Lorenzo Cr.	USACE	Levees, concrete channel	San Lorenzo, Hayward
Walnut Cr.	Walnut Cr., San Ramon Cr., Grayson Cr., Pacheco Cr., Pine Cr., Galindo Cr.	USACE	Levees, channel stabilization, channel improvement	Walnut Creek, Concord, Pacheco, Vine Hill, Pleasant Hill
Corte Madera Cr.	Corte Madera Cr. and tributaries	USACE (Marin Co. FCWCD)	Channel improvement	San Anselmo, Ross, Kentfield, Larkspur, Corte Madera, Greenbrae, Fairfax
Novato Cr.	Novato Cr., Warner Cr., Avichi Cr.	Marin Co. FCWCD	Channel improvement	Novato
Coyote and Berryessa Crs.	Coyote Cr. (Santa Clara Co.), Berryessa Cr.	USACE (Santa Clara Valley WD)	Channel improvement	Alviso, Milpitas, San Jose
Guadalupe R.	Guadalupe R.	USACE (Santa Clara Valley WD)	Channel improvement, bypass tunnel	San Jose
San Francisquito Cr.	San Francisquito Cr.	San Francisquito Creek JPA	Levee restoration	East Palo Alto, Menlo Park
Napa R. Basin	Napa R., Napa Cr.	USACE (Napa Co. FCWCD)	Levees, floodwalls, bypass, channel improvements	Napa, St. Helena
Petaluma R.	Petaluma R.	Sonoma Co. WA	Floodwalls	Petaluma
Wildcat and San Pablo Crs.	Wildcat Cr., San Pablo Cr.	USACE (Contra Costa Co. FCWCD)	Levees, channel, channel improvements, sedimentation basins	San Pablo, Richmond
Coyote Cr.	Coyote Cr. (Marin Co.)	USACE	Lined and unlined channels	Tamalpais Valley

Facility	Stream	Owner (Sponsor)	Description	Protects
Green Valley Cr.	Green Valley Cr., Dan Wilson Cr.	USACE	Realigned and enlarged channel	Agricultural and urbanizing lands north of Suisun Bay
Pinole Cr.	Pinole Cr.	USACE	Unlined channel	Pinole
Non-storage flood control facilities				
Rheem Cr.	Rheem Cr.	USACE	Lined and unlined channels	San Pablo
Rodeo Cr.	Rodeo Cr.	USACE	Lined and unlined channels	Rodeo
San Leandro Cr.	San Leandro Cr.	USACE	Lined and unlined channels	Oakland, San Leandro
Lower Pine Cr.	Pine Creek	Contra Costa FCWCD (NRCS)	Detention basin	Concord
Napa R.	Napa R.	Napa Co. FCWCD (NRCS)	Contributions to Napa R. Basin Project	Napa, St. Helena
Lower Silver Cr.	Silver Cr.	Santa Clara Valley WD (NRCS)	Channel improvement	San Jose

Note: taf=thousand acre-feet

Table SFB-14 Groundwater Management Plans in the San Francisco Bay Hydrologic Region

Map Label	Agency Name	Date	County	Basin Number	Basin Name
SF-1	**Santa Clara Valley**	2001	Santa Clara	2-9.02	Santa Clara Subbasin
	No signatories on file				
SF-2	**Sonoma County**	2007	Sonoma	2-2.02	Sonoma Valley Subbasin
	City of Sonoma			2-19	Kenwood Valley
	Valley of the Moon Water				
SF-3	**Zone 7 Water Agency**	2005	Alameda	2-10	Livermore Valley
	No signatories on file		Contra Costa	2-7	San Ramon Valley
SR-27	**Solano Irrigation District**	2006	Solano	5-21.66	Solano Subbasin
	No signatories on file			2-3	Suisun-Fairfield Valley
					Non-B118 Basin

Table SFB-15 Assessment for SB 1938 GWMP Required Components, SB 1938 GWMP Voluntary Components, and Bulletin 118-03 Recommended Components

SB 1938 GWMP Required Components	Percent of Plans that Meet Requirement
Basin Management Objectives	67%
BMO: Monitoring/Management Groundwater Levels	100%
BMO: Monitoring Groundwater Quality	100%
BMO: Inelastic Subsidence	100%
BMO: SW/GW Interaction & Affects to Groundwater Levels & Quality	67%
Agency Cooperation	100%
Map	100%
Map: Groundwater basin area	100%
Map: Area of local agency	100%
Map: Boundaries of other local agencies	100%
Recharge Areas (1/1/2013)	Not Assessed
Monitoring Protocols	67%
MP: Changes in groundwater levels	100%
MP: Changes in groundwater quality	100%
MP: Subsidence	100%
MP: SW/GW Interaction & Affects to Groundwater Levels & Quality	67%
SB 1938 GWMP Voluntary Components	**Percent of Plans that Include Component**
Saline Intrusion	67%
Wellhead Protection & Recharge	67%
Groundwater Contamination	67%
Well Abandonment & Destruction	67%
Overdraft	67%
Groundwater Extraction & Replenishment	67%
Monitoring	100%
Conjunctive Use Operations	100%
Well Construction Policies	100%
Construction and Operation	67%
Regulatory Agencies	100%
Land Use	67%
Bulletin 118-03 Recommended Components	**Percent of Plans that Include Component**
GWMP Guidance	67%
Management Area	100%
BMOs, Goals, & Actions	67%
Monitoring Plan Description	67%
IRWM Planning	67%
GWMP Implementation	67%
GWMP Evaluation	67%

Table SFB-16 Factors Contributing to Successful Groundwater Management Plan Implementation in the San Francisco Bay Hydrologic Region

Key components	Respondents
Data collection and sharing	4
Outreach and education	3
Developing an understanding of common interest	4
Sharing of ideas and information with other water resource managers	4
Broad stakeholder participation	4
Adequate surface water supplies	4
Adequate regional and local surface storage and conveyance systems	4
Water budget	4
Funding	4
Time	4
State funding for groundwater management programs	1
Stronger coordination with land use agencies	1

Table SFB-17 Factors Limiting Successful Groundwater Management Plan Implementation in the San Francisco Bay Hydrologic Region

Limiting Factors	Respondents
Funding for groundwater management projects	3
Funding for groundwater management planning	2
Unregulated Pumping	1
Groundwater Supply	-
Participation across a broad distribution of interests	1
Lack of Governance	-
Surface storage and conveyance capacity	1
Understanding of the local issues	-
Access to planning tools	-
Outreach and education	-
Data collection and sharing	-
Funding to assist in stakeholder participation	3

Table SFB-18 Groundwater Ordinances that Apply to Counties in the San Francisco Bay Hydrologic Region

County	Groundwater Management	Guidance Committees	Export Permits	Recharge	Well Abandonment & Destruction	Well Construction Policies
San Francisco	-	-	-	-	Y	Y
Sonoma	-	-	-	-	Y	Y
Napa	-	Y	-	-	Y	Y
Solano	-	-	-	-	Y	Y
San Mateo	-	-	-	-	Y	Y
Alameda	-	-	-	-	Y	Y

Table SFB-19 Proposed Water Enhancement Projects, San Francisco Bay Hydrologic Region (Draft)

Table SFB-10 Proposed Water Enhancement Projects, San Francisco Bay Hydrologic Region

Project ID #	Project Name	Project Proponent	Project Status: Design % Complete	DAC?	Project Abstract
1	Bay Area Regional Conservation and Education Program	Zone 7 Water Agency (Zone 7)	100%	No	The Regional Water Conservation and Education Program is an existing program that is implemented by 12 Bay Area agencies. The IRWM Round 2 Implementation funding will expand the implementation of existing water conservation practices in the Bay Area, resulting in reduced potable water use and improve the existing Bay Area regional water conservation initiative. A suite of program elements will promote high-efficiency technologies and best water conservation practices that improve indoor and outdoor water use efficiency throughout the San Francisco Bay Area.
2	East Bayshore Recycled Water Project Phase 1A (Emeryville)	East Bay Municipal Utilities District (EBMUD)	90%	Yes	The East Bayshore Recycled Water Project (EBRWP) will ultimately provide up to 2.5 mgd (2,800 AFY) of tertiary treated recycled water to customers within the Cities of Alameda, Albany, Berkeley, Emeryville, and Oakland. In October 2012, EBMUD completed a segment of the East Bayshore recycled water transmission pipeline with support from DWR's Proposition 84, Round 1 Implementation Grant. The next phase of the EBRWP project (Phase 1A Emeryville) will extend the recycled water transmission pipeline by about 5,100 feet to the north.
3	Lagunitas Creek Watershed Sediment Reduction and Management Project	Marin Municipal Utilities District (MMWD)	50%	No	This sediment reduction project will improve water quality and streambed habitat for the benefit of coho salmon and steelhead trout populations in Lagunitas Creek; and improve fish passage into two tributary streams to Lagunitas Creek. The project involves repair of three stream crossings along the Cross Marin Trail, which is adjacent to Lagunitas Creek, to reduce fine sediment loading into Lagunitas Creek and its tributary streams. The stream crossing improvements will safeguard the Nicasio Transmission Line, a major public water supply transmission line for the area, and stabilize and restore recreational access within National Park Service and California State Parks lands, along the Cross Marin Trail.
4	Marin/Sonoma Conserving Our Watersheds: Agricultural BMP Projects	Marin Resource Conservation District (Marin RCD)	15%	No	This project will implement critical environmental Best Management Practices (BMPs) on agricultural lands in Marin and Sonoma counties. These BMPs are already identified in watershed plans in Marin and a portion of Sonoma County. The BMP projects will focus on improving water quality, conserving water, and enhancing wildlife ecosystems on agricultural lands.
5	Napa Milliken Creek Flood Damage Reduction and Fish Passage Barrier Removal	Napa County	20%	No	The Project involves three integrated elements along Milliken Creek: 1) removal of a dam and restoration of the stream, 2) construction of a flood bypass/weir to ensure a flood detention area does not overflow into neighboring homes, and 3) grading/landscape improvements to ensure adjacent low lying properties receive a comparable level of flood protection. The project will prevent flooding of a neighborhood of over 50 homes. The dam is currently a passage barrier for steelhead.
6	North Bay Water Reuse Program – Sonoma Valley CSD 5th Street East/McGill Road Recycled Water Project	Sonoma Valley County Sanitation District	40%	No	The Sonoma Valley County Sanitation District (CSD) 5th Street East/McGill Road Recycled Water Project, a Phase 2 component of North Bay Water Reuse Program, consists of two recycled water sub-projects located in Sonoma Valley. The total recycled water yield from the Project is approximately 200 acre-feet per year (AFY). The Project will increase utilization of recycled water for non-potable water demands, and will improve water supply reliability for the region through the creation of a drought-proof supply that can offset use of potable water supplies for non-potable demands.
7	Oakland Sausal Creek Restoration Project	City of Oakland	100%	Yes	This project involves restoring 754 linear feet of Sausal Creek in Dimond Park in Oakland, California, including 180 feet of culvert daylighting. The project includes restoration of channel function, stream bank stabilization, erosion prevention, native plant restoration, native trout habitat improvement, and interpretive site features.
8	Pescadero Water Supply and Sustainability Project	San Mateo County	90%	Yes	This project will construct a new municipal groundwater well and 140,000 gallon storage tank for approximately 100 households within the Town of Pescadero. The current water supply system recently experienced a water outage in 2011 which left customers with no running water. Emergency connections are not available and the standby well is unreliable. The project would provide a reliable water supply to the community without increasing extracted groundwater. This project also includes implementing a water conservation program for the community.
9	Petaluma Flood Reduction, Water & Habitat Quality, and Recreation Project for Capri Creek	City of Petaluma	90%	No	This project implements improvements to an existing engineering drainage swale to restore a natural riparian corridor aesthetic. The goals of the project are to achieve flood reduction, habitat enhancement, groundwater recharge opportunities (limited), expand recreational and educational amenities, and water quality improvements. The project compliments current efforts in the Petaluma River watershed to integrate other flood control projects with multiple benefits.
10	Redwood City Bayfront Canal and Atherton Channel Flood Improvement and Habitat Restoration Project	City of Redwood City	15%	No	This project will mitigate chronic and widespread flooding in the Bayfront Canal (Redwood City) and Atherton Channel (Menlo Park) neighborhoods by routing flood flows from the Bayfront Canal and Atherton Channel into managed ponds that are part of the Ravenswood Pond Complex portion of the South Bay Salt Pond Restoration Project. This will provide detention for these drainage areas, and redirected runoff will be used to enhance wetland habitat. This project will provide significant opportunity for alleviating flooding concerns, improving runoff water quality from nearby neighborhoods, and supporting additional recreational trails.
11	Regional Groundwater Storage and Recovery Project Phase 1A – South Westside Basin, Northern San Mateo County	San Francisco Public Utilities Commission (SFPUC)	100%	No	The SFPUC, along with Partner Agencies: the cities of Daly City and San Bruno and the California Water Service Company, proposes to develop a regional conjunctive use project in the South Westside Groundwater Basin for use during drought conditions. The purpose of the project is to use the basin as an underground reservoir to store water during periods when surface water supply can be made available to offset groundwater pumping by the Partner Agencies, leading to an accumulation of stored groundwater that can be used during drought years. Phase 1A, proposed for funding in this application, will include the construction of 5 groundwater wells.
12	Richmond Breuner Marsh Restoration Project	East Bay Regional Park District (EBRPD)	90%	Yes	EBRPD proposes to create, restore, enhance, and protect 164 acres of crucial habitat in Breuner Marsh at Point Pinole Regional Shoreline Park in the City of Richmond on the San Francisco Bay shoreline, Contra Costa County, California. The goal of this wetland restoration project is to provide long-term, self-sustaining tidal wetlands, seasonal wetlands, and coastal prairie to create valuable habitat for special-status species and for public access for compatible passive recreation and public education.

Project ID #	Project Name	Project Proponent	Project Status: Design % Complete	DAC?	Project Abstract
13	Roseview Heights Infrastructure Upgrades for Water Supply and Quality Improvement, Santa Clara County	Roseview Heights Mutual Water Company (RHMWC)	95%	No	This project will replace the existing, aging water system infrastructure before emergency repairs or emergency replacement become necessary. The project will improve water supply reliability, water quality, and fire suppression capability by replacing and upgrading water tanks and water mains and adding fire hydrants.
14	San Francisco Bay Climate Change Pilot Projects Combining Ecosystem Adaptation, Flood Risk Management and Wastewater Effluent Polishing	Association of Bay Area Governments (ABAG)	20%	No	This project involves construction of a demonstration ecotone slope on an existing parcel owned by the Oro Loma Sanitary District. An ecotone slope provides a cost effective and environmentally friendly response to sea level rise. The pilot project will be studied to determine its efficacy and optimal design. The elements of the optimal design will then be built into a second phase of pilot projects at other sites in the Bay Area.
15	San Francisco International Airport Reclaimed Water Facility	City and County of San Francisco (CCSF) – Airport Commission	30%	No	This project will provide the necessary infrastructure needed to reuse 100% of treated effluent at the airport terminals for non-potable reuse, thus reducing imported water demand on the Hetch Hetchy water system. An existing recycled water facility will be upgraded to treat 1.0 MGD of high quality industrial, sanitary, and stormwater effluent with microfiltration membrane treatment and hypochlorite disinfection to satisfy Title 22 reclaimed water criteria.
16	San José Green Streets & Alleys Demonstration Projects	City of San José	20%	Yes	This project will construct Low Impact Development (LID) improvements along a residential collector-type street and alley segments in a disadvantaged community to demonstrate a range of approaches for retrofitting existing urban streets with LID stormwater management features. LID permeable pavement and infiltration facilities will be installed to eliminate sediment and ponding in the alleys, improve stormwater quality, and make the alleys a community amenity. These projects will add to a regional collection of demonstration LID retrofit projects.
17	San Pablo Rheem Creek Wetlands Restoration Project	Contra Costa Water District (CCWD)	30%	Yes	This project will create seasonal wetlands on a ten-acre parcel adjacent to Rheem Creek and Breuner Marsh, located in the City of Richmond. The project will also improve the quality of stormwater that ultimately flows to San Pablo Bay. In addition, the project will lower potential flood impacts from Rheem Creek in neighborhoods within the cities of San Pablo and Richmond.
18	St. Helena Upper York Creek Dam Removal and Ecosystem Restoration Project	City of St. Helena	30%	No	This project will remove the Upper York Creek Dam, a barrier to fish passage. The dam removal will provide access to an additional 1.7 miles of spawning and rearing habitat. The project will also restore approximately 2 acres of riparian corridor along York Creek, resulting in diverse, multi-story, shaded aquatic and riparian habitat; improved water quality through removal of the potential for accidental sediment releases during maintenance; and restored gravel yield to the channel downstream of the dam and the Napa River, which is sediment-starved at it confluence with York Creek.
19	Students and Teachers Restoring a Watershed (STRAW) Project – North and East Bay Watersheds	Point Reyes Bird Observatory Conservation Science (PRBO)	50%	Yes	The STRAW Project will implement a minimum of 20 habitat restoration projects in Bay Area watersheds with students and community members from Alameda, Contra Costa, Marin, Napa, San Francisco, Solano and Sonoma counties. STRAW features professionally designed and implemented habitat restoration projects integrated with an innovative and time-tested education program that provides water quality benefits, habitat improvement, and positive impacts on economic, social, and environmental sustainability. STRAW coordinates with and sustains a network of committed teachers, students, restoration specialists, landowners and managers, and other community members to complete the restoration projects.

Table SFB-20 Potential New Data Monitoring Programs, San Francisco Bay Hydrologic Region

Program	Potential Implementing Agency	Program Description
Water Supply-Water Quality		
Regional Groundwater Monitoring Program	DWR	Initiate a regional groundwater monitoring program, which combines disparate or various local groundwater monitoring efforts in a single, comprehensive assessment of groundwater quantity and quality for basins within the region. Regional groundwater assessments should be conducted every 5 years.
Regional Monitoring of Emerging Contaminants	SWRCB	Conduct regional monitoring of emerging contaminants, such as endocrine disrupting compounds, in water, sediment, and aquatic species. Expand upon the existing Regional Monitoring Program for Trace Substances to include emerging contaminants. Extend the Regional Monitoring Program (RMP) to include monitoring of the quality of urban creeks in addition to sites within the San Francisco Bay.
Wastewater and Recycled Water		
Regional Recycled Water Reporting	RWQCB	Regional compilation of quantity and quality of recycled water produced and used within the region. This system would track and encourage utilization of recycled water to conserve potable supplies. Information is already provided to RWQCB.
Nonpoint Source Pollution Control Program	SWRCB	The State Water Resources Control Board is developing the Nonpoint Source Pollution Control Program to track and monitor nonpoint source pollution in the Bay Area, but it is not yet effective. The Program could be expanded to collect both runoff quantity and quality information.
Flood Protection and Stormwater Management		
Regional Monitoring of Impervious Surfaces	RWQCB	Regional monitoring of trends in urbanization through tracking the extent of impervious surfaces and undeveloped lands with the use of GIS mapping. This information can be utilized when designing restoration efforts and to examine the effects of altered hydrology on streams, and habitats. Additionally, this information will be useful for stormwater and flood control management agencies to assess application of appropriate BMPs and management measures according to the extent of imperviousness in the region.
Regional Storm Drainage Mapping	RWQCB	Collaborative effort to develop a regional map showing locations of creeks, underground culverts, storm drains, and flood control channels. Use the Oakland Museum Creek Maps as an example for a region-wide effort to map storm drainage networks. This information will improve regional efforts for habitat restoration, flood control, and water-quality monitoring.
Regional Monitoring of Floodplains	BAFPAA	Regional mapping and monitoring of floodplains, including acreage protected, connectivity, and management techniques. Monitoring information would facilitate planning, design, and execution of flood-protection projects.

Watershed Management, Habitat Protection, and Restoration		
Regional Monitoring of Stream Channel Conditions	CDFW	Regional mapping and monitoring of channel bed and bank conditions, including extent of functioning riparian corridors. Regional mapping and monitoring of sediment source, transport, and depositional areas. This information will be useful to monitor the success of creek restoration projects, assess the need for future restoration efforts, and track habitat conditions for wildlife and aquatic habitat. Due to the extent of urbanization in the region, these data should be gathered in conjunction with local flood control and stormwater management agencies.
Regional Monitoring of In-Stream Habitat Conditions	USEPA-Office of Research and Development, CDFW	Expand upon the Western Pilot Environmental Monitoring and Assessment Program (WEMAP) to implement standardized monitoring of in-stream habitat conditions (water quality, fish populations, benthic populations) within the region. Establish protocols and baseline data to assess urbanized habitat conditions.
Regional Monitoring of Wildlife Corridors, Populations, and Biodiversity	CDFW	Establish a regional monitoring system for wildlife corridors, populations, and species richness (for amphibians, birds, and mammals). This could expand upon the CNDDB, focusing solely on population monitoring within the region.
Regional Monitoring of Invasive Species	CDFW, USFWS	Regional monitoring program for presence and absence of invasive plant species (beyond Spartina). The program would provide information to target eradication and restoration activities.
Regional Monitoring of Native At-Risk and Special Status Species	CDFW, USFWS	Regional program to track presence or absence of at-risk native and special status species in the Bay Area.

Table SFB-21 Conceptual Growth Scenarios

Scenario	Population Growth	Development Density
LOP-HID	Lower than Current Trends	Higher than Current Trends
LOP-CTD	Lower than Current Trend	Current Trends
LOP-LOD	Lower than Current Trends)	Lower than Current Trends
CTP-HID	Current Trends	Higher than Current Trends
CTP-CTD	Current Trends	Current Trends
CTP-LOD	Current Trends	Lower than Current Trends
HIP-HID	Higher than Current Trends	Higher than Current Trends
HIP-CTD	Higher than Current Trends	Current Trends
HIP-LOD	Higher than Current Trends	Lower than Current Trends

Source: California Department of Water Resources 2012.

Table SFB-22 Growth Scenarios (Urban) — San Francisco Bay

Scenario [a]	2050 Population (thousand)	Population Change (thousand) 2006 [b] to 2050	Development Density	2050 Urban Footprint (thousand acres)	Urban Footprint Increase (thousand acres) 2006 [c] to 2050
LOP-HID	6,135.7 [d]	-21.5	High	706.1	23.9
LOP-CTD	6,135.7	-21.5	Current Trends	708.9	26.7
LOP-LOD	6,135.7	-21.5	Low	712.2	30.0
CTP-HID	7,666.8 [e]	1,509.6	High	770.8	88.6
CTP-CTD	7,666.8	1,509.6	Current Trends	779.1	96.9
CTP-LOD	7,666.8	1,509.6	Low	787.0	104.8
HIP-HID	11,039.4 [f]	4,882.2	High	863.3	181.1
HIP-CTD	11,039.4	4,882.2	Current Trends	880.8	198.6
HIP-LOD	11,039.4	4,882.2	Low	896.9	214.7

Source: California Department of Water Resources 2012.

Notes:

[a] See Table SFB-21 for scenario definitions

[b] 2006 population was 6,157.2 thousand.

[C] 2006 urban footprint was 682.2 thousand acres.

[d] Values modified by the California Department of Water Resources (DWR) from the Public Policy Institute of California.

[e] Values provided by the California Department of Finance.

[f] Values modified by DWR from the Public Policy Institute of California.

Table SFB-23 Growth Scenarios (Agriculture) — San Francisco Bay

Scenario[a]	2050 Irrigated Land Area[b] (thousand acres)	2050 Irrigated Crop Area[c] (thousand acres)	2050 Multiple Crop Area[d] (thousand acres)	Change in Irrigated Crop Area (thousand acres) 2006 to 2050
LOP-HID	86.6	87.7	1.1	+5.1
LOP-CTD	86.2	87.3	1.1	+4.7
LOP-LOD	85.6	86.7	1.1	+4.1
CTP-HID	79.8	80.8	1.0	-1.8
CTP-CTD	79.0	80.0	1.0	-2.6
CTP-LOD	78.1	79.1	1.0	-3.5
HIP-HID	69.6	70.5	0.9	-12.1
HIP-CTD	67.5	68.4	0.9	-14.2
HIP-LOD	65.5	66.4	0.9	-16.2

Source: California Department of Water Resources 2012.

Notes:

a See Table SFB-21 for scenario definitions

b 2006 Irrigated land area was estimated by the California Department of Water Resources (DWR) to be 81.6 thousand acres.

c 2006 Irrigated crop area was estimated by DWR to be 82.6 thousand acres.

d 2006 multiple crop area was estimated by DWR to be 1.0 thousand acres.

Table SFB-24 Resource Management Strategies Addressed in IRWMP's in the San Francisco Bay Hydrologic Region

Resource Management Strategy	IRWMP 1	IRWMP 2
Agricultural Water Use Efficiency		
Urban Water Use Efficiency		
Conveyance – Delta		
Conveyance – Regional/Local		
System Reoperation		
Water Transfers		
Conjunctive Management & Groundwater		
Desalination		
Precipitation Enhancement		
Recycled Municipal Water		
Surface Storage – CALFED		
Surface Storage – Regional/Local		
Drinking Water Treatment and Distribution		
Groundwater and Aquifer Remediation		
Match Water Quality to Use		
Pollution Prevention		
Salt and Salinity Management		
Agricultural Lands Stewardship		
Economic Incentives		
Ecosystem Restoration		
Forest Management		
Land Use Planning and Management		
Recharge Areas Protection		
Water-Dependent Recreation		
Watershed Management		
Flood Risk Management		
Flood Management		
Desalination (Brackish and Sea Water)		
Salt and Salinity Management		

Figure SFB-1 San Francisco Bay Hydrologic Region

Figure SFB-2 Principal Watersheds in the San Francisco Bay Hydrologic Region

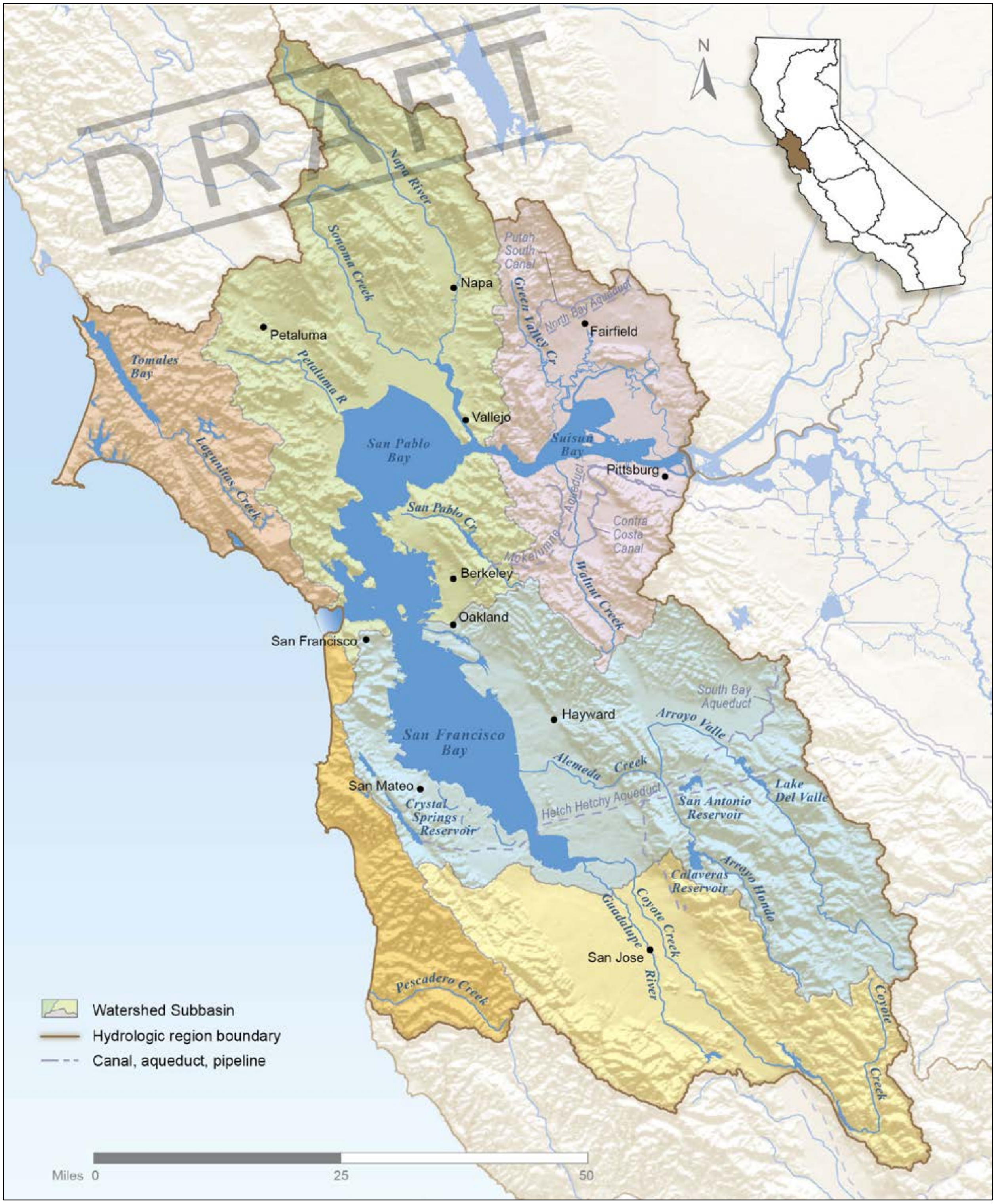


Figure SFB-3 Alluvial Groundwater Basins and Subbasins within the San Francisco Bay Hydrologic Region

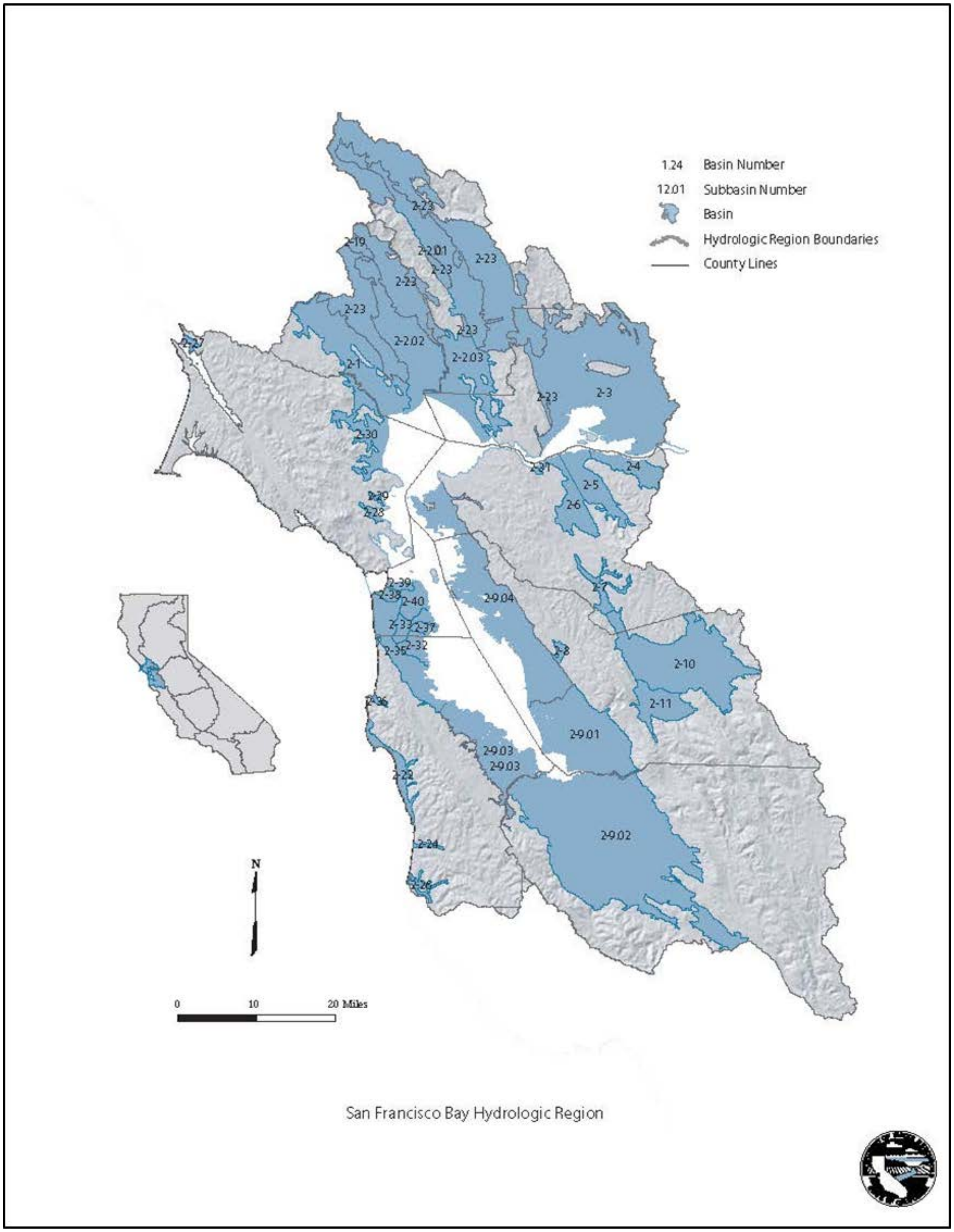


Figure SFB-4 Number of Well Logs by County and Use for the San Francisco Bay Hydrologic Region (1977-2010)

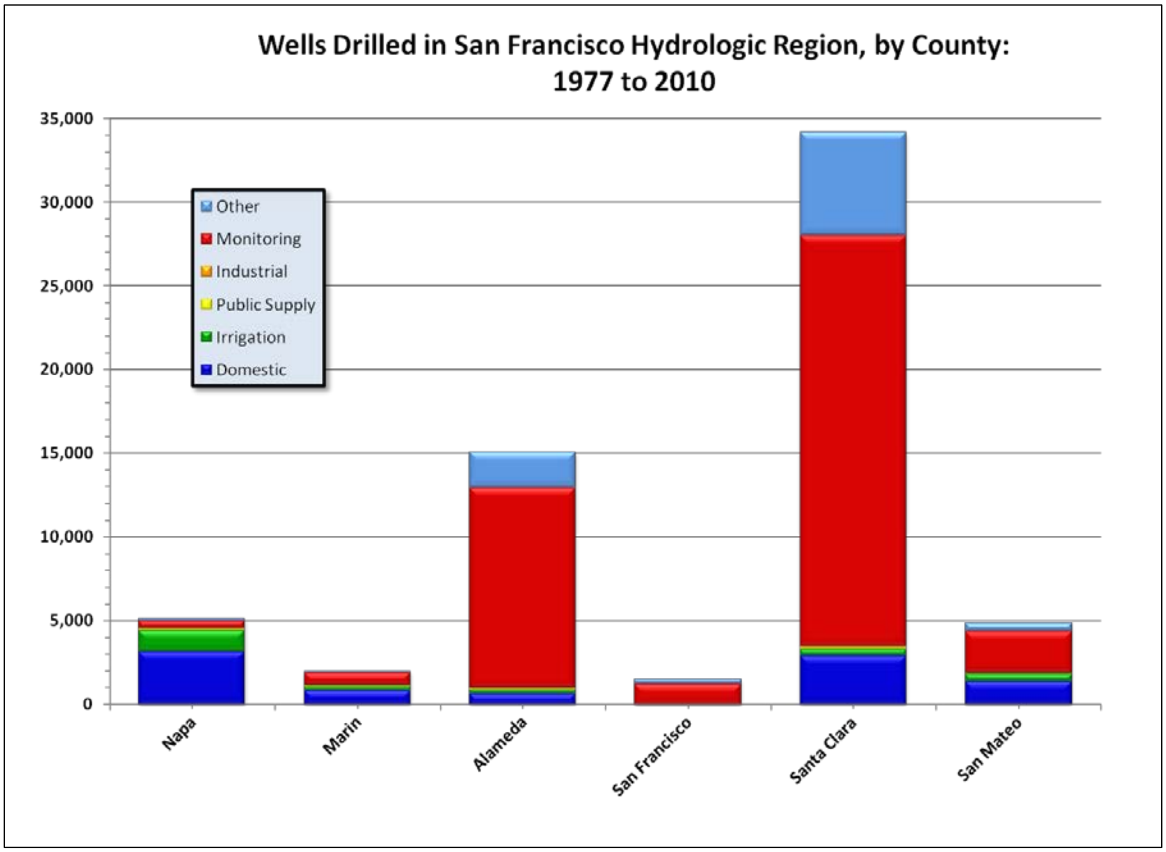


Figure SFB-5 Percentage of Well Logs by Use for the San Francisco Bay Hydrologic Region (1977–2010)

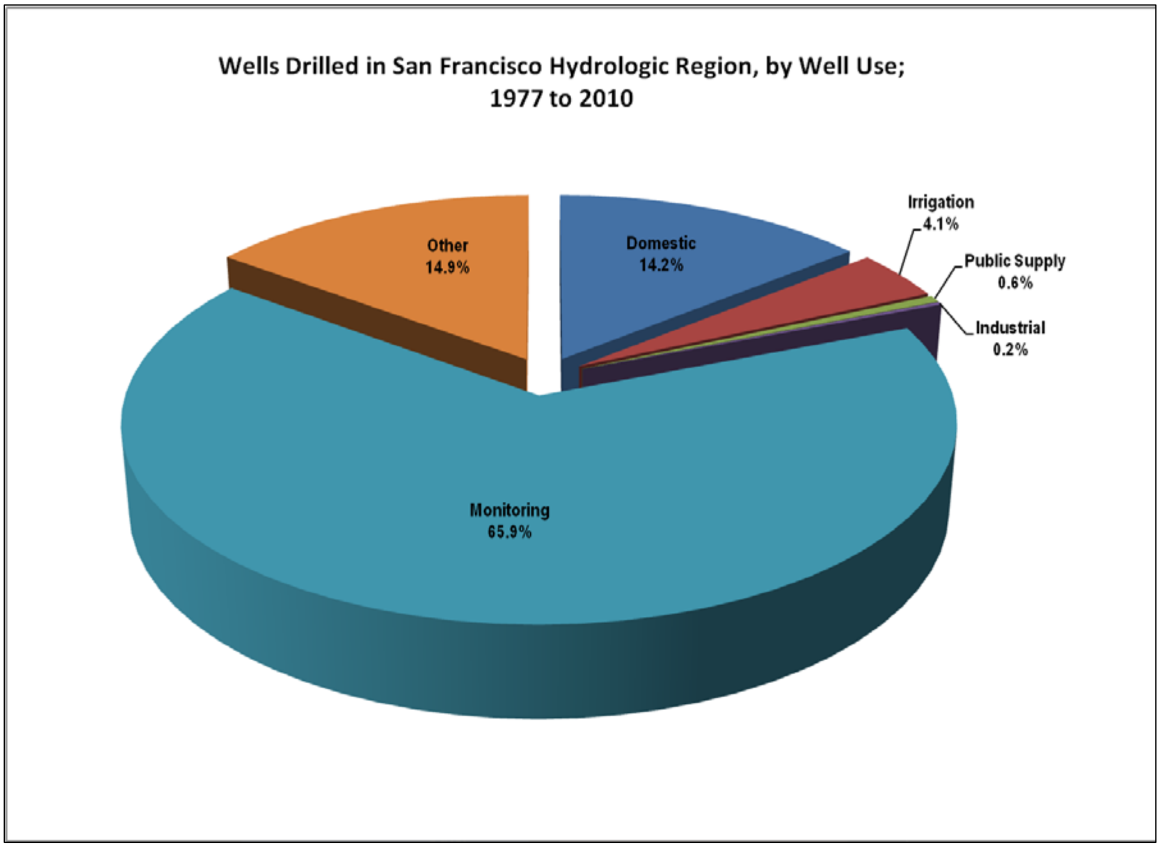


Figure SFB-6 Number of Well Logs Filed per Year by Use for the San Francisco Bay Hydrologic Region (1977–2010)

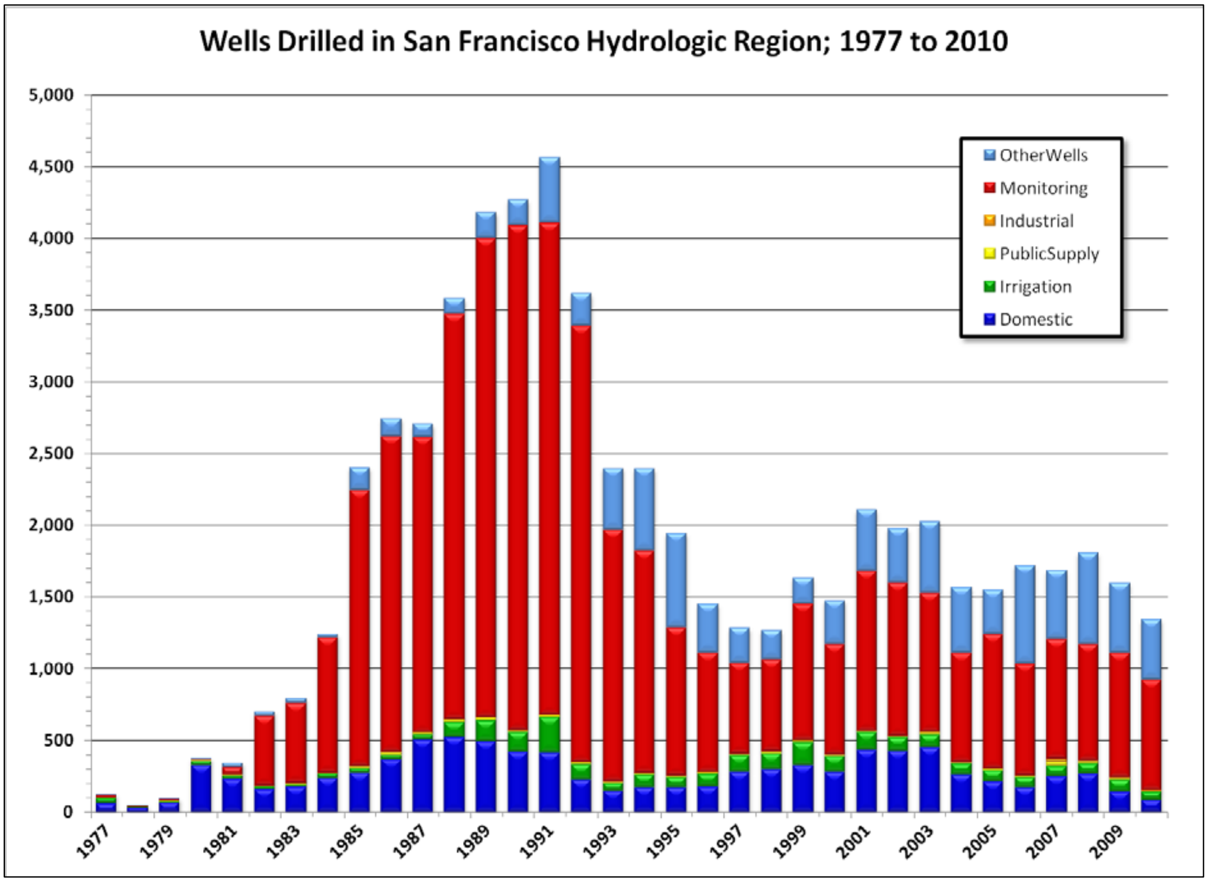


Figure SFB-7 CASGEM Groundwater Basin Prioritization for the San Francisco Bay Hydrologic Region

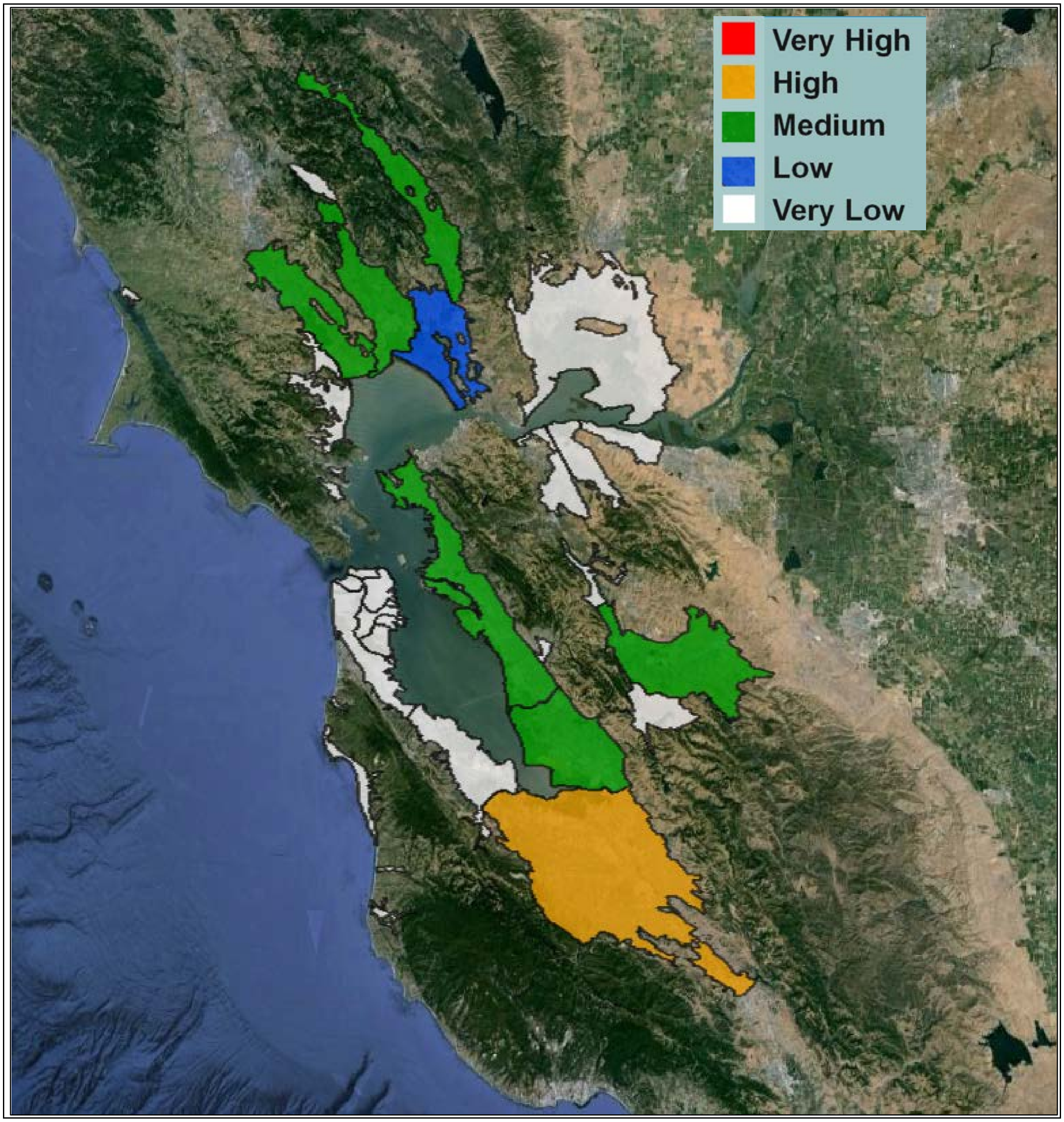
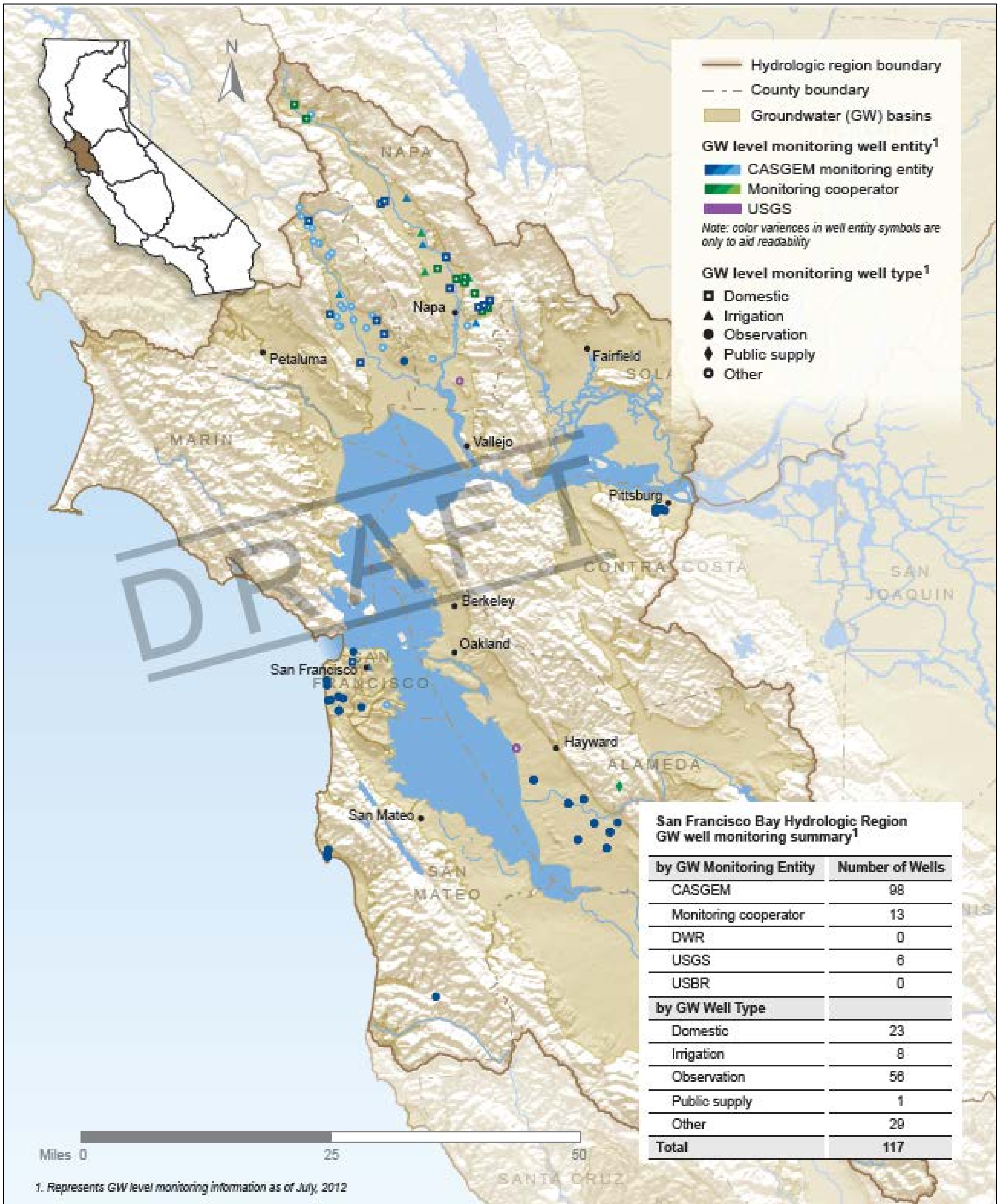


Figure SFB-8 Monitoring Well Location by Agency, Monitoring Cooperator, and CASGEM Monitoring Entity in the San Francisco Bay Hydrologic Region



San Francisco Bay Hydrologic Region GW well monitoring summary[1]

by GW Monitoring Entity	Number of Wells
CASGEM	98
Monitoring cooperator	13
DWR	0
USGS	6
USBR	0
by GW Well Type	
Domestic	23
Irrigation	8
Observation	56
Public supply	1
Other	29
Total	117

Source: Department of Water Resources, CWP 2013

Figure SFB-9 Percentage of Monitoring Wells by Use in the San Francisco Bay Hydrologic Region

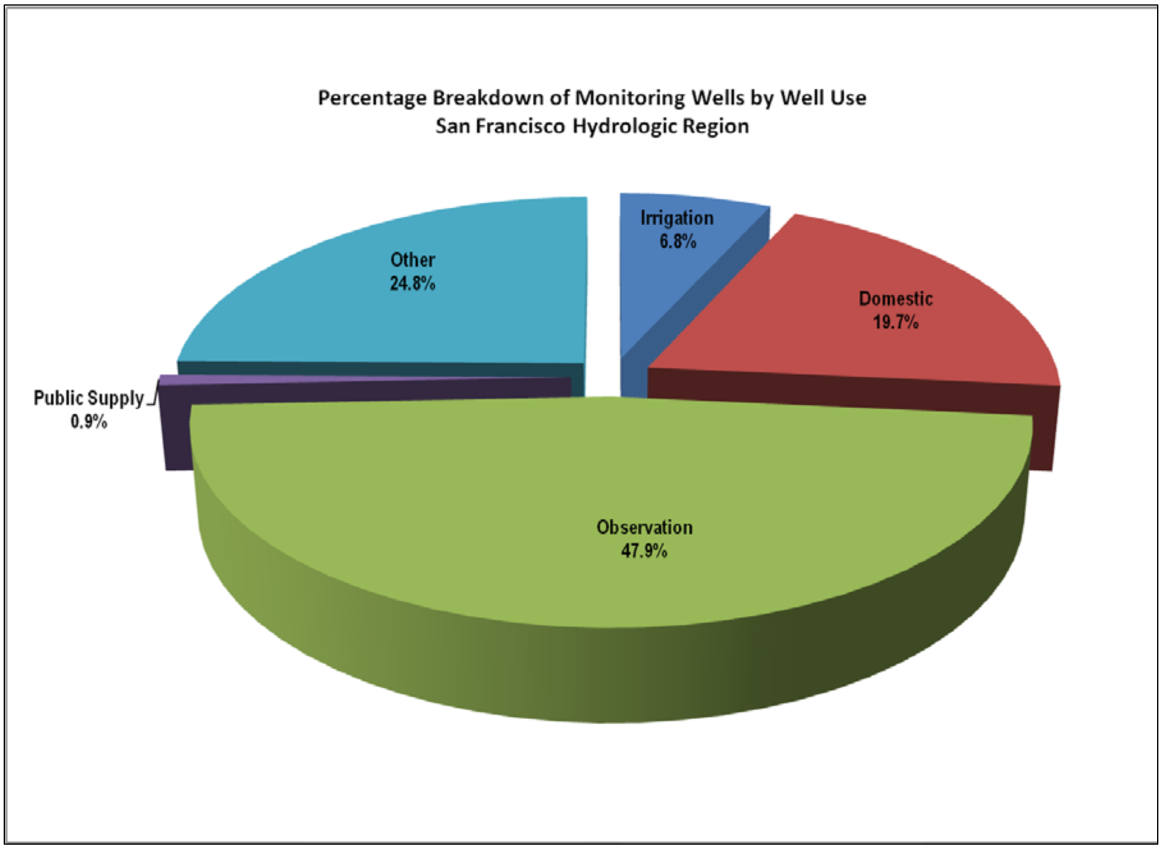


Figure SFB-10 San Francisco Bay Hydrologic Region Inflows and Outflows in 2010

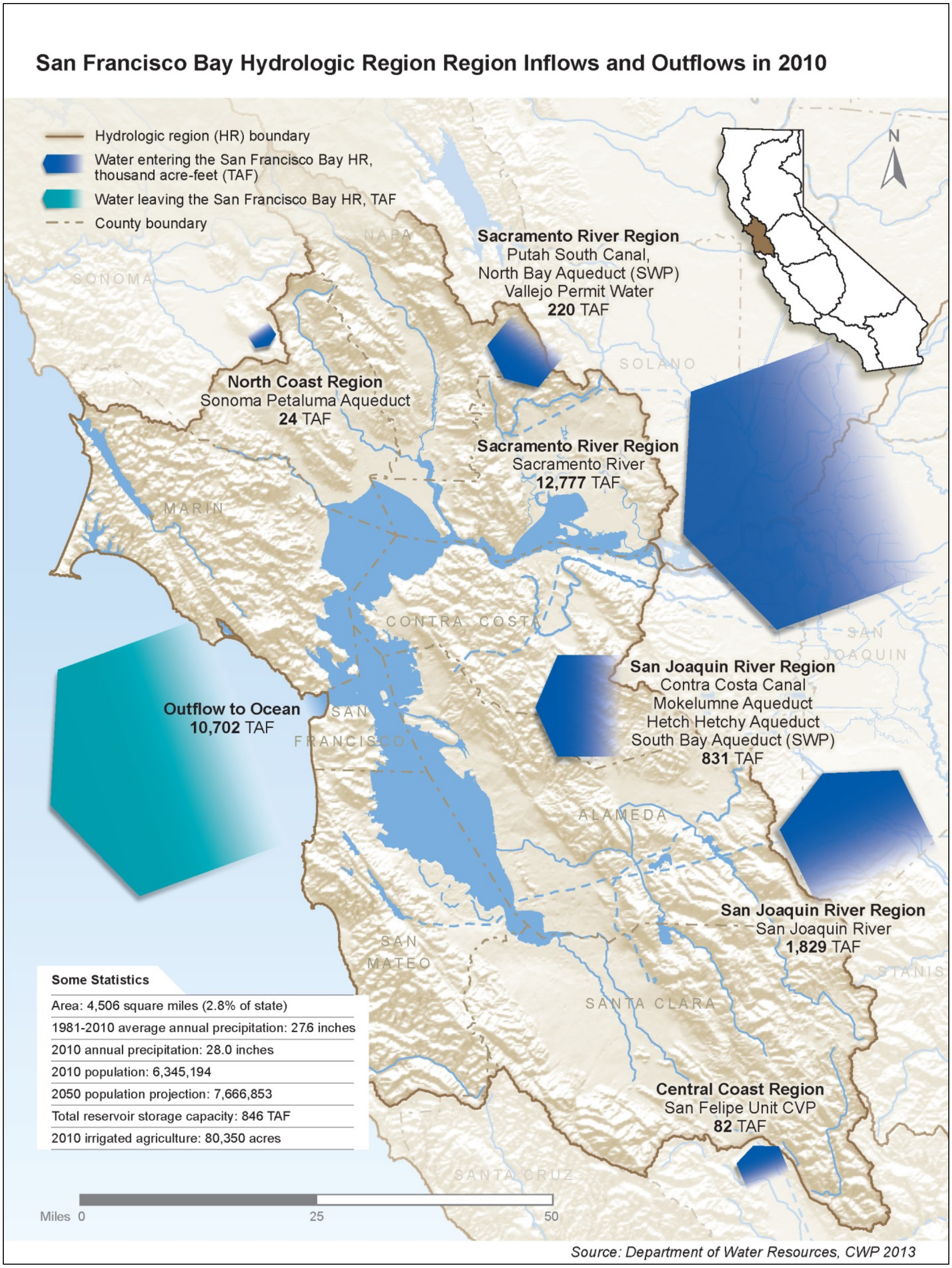


Figure SFB-11 Contribution of Groundwater to the San Francisco Bay Hydrologic Region Water Supply by Planning Area (2005-2010)

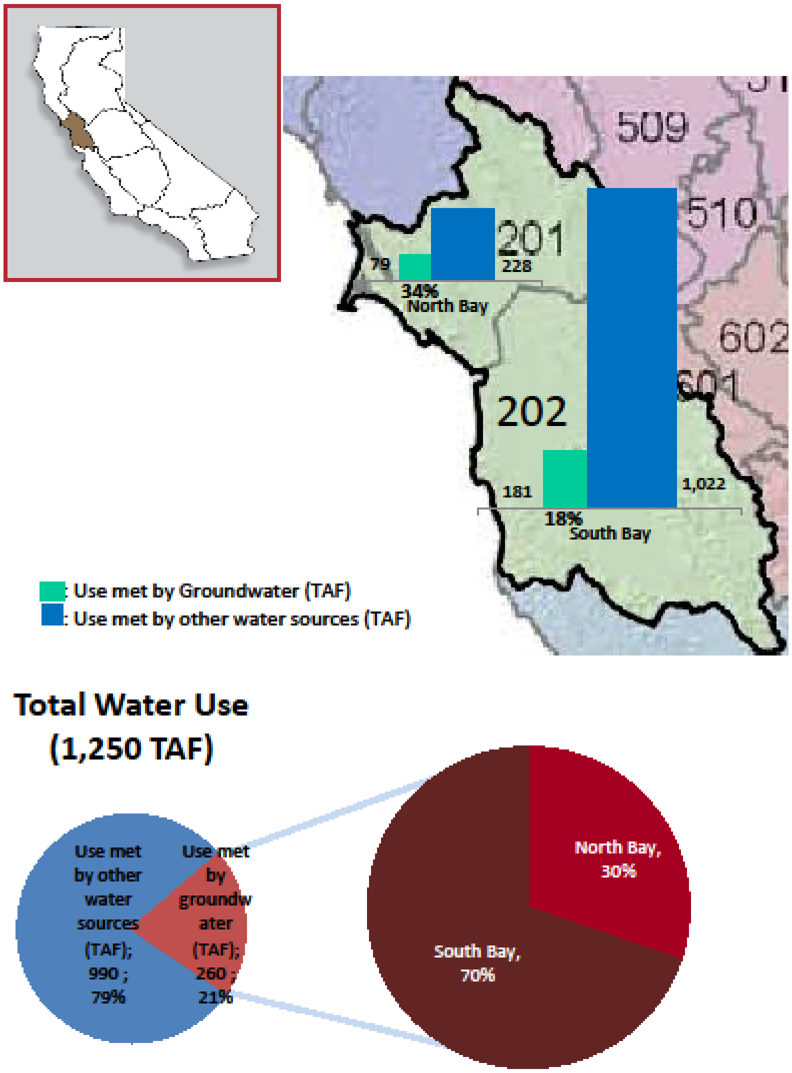


Figure SFB-12 San Francisco Bay Hydrologic Region Annual Groundwater Water Supply Trend (2002-2010)

[**PLACEHOLDER:** Will replace with San Francisco Bay figure for final draft.]

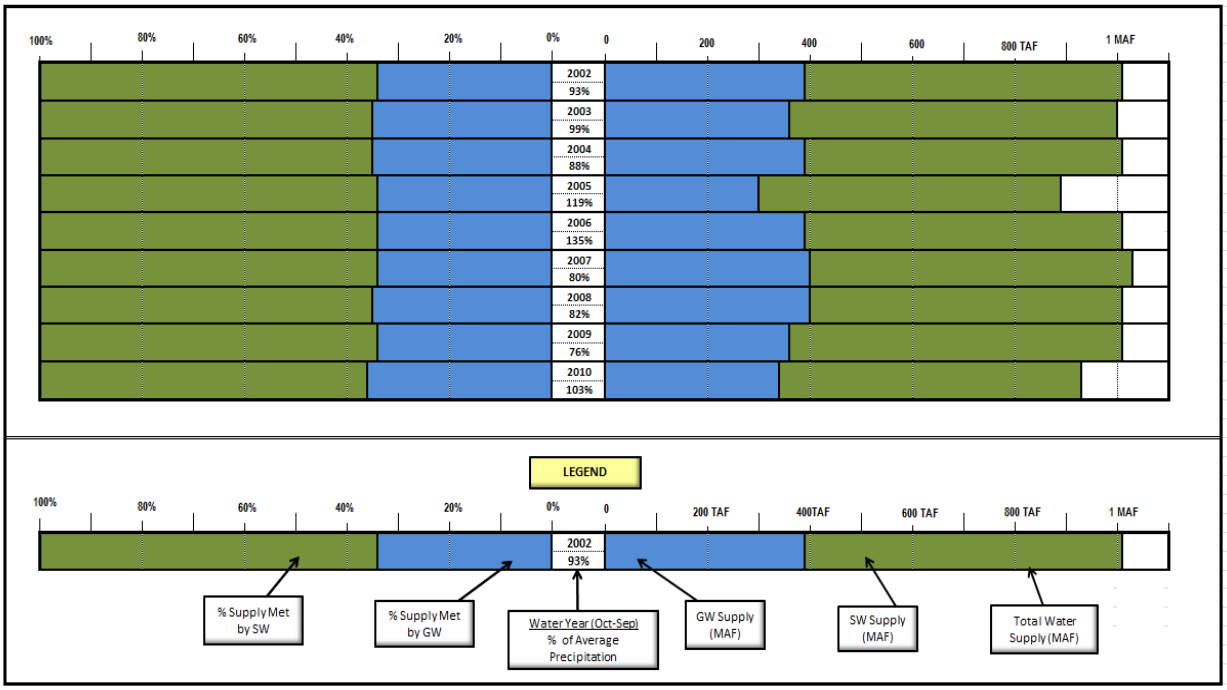


Figure SFB-13 San Francisco Bay Hydrologic Region Annual Groundwater Supply Trend by Type of Use (2002-2010)

[**PLACEHOLDER:** Will replace with San Francisco Bay figure for final draft.]

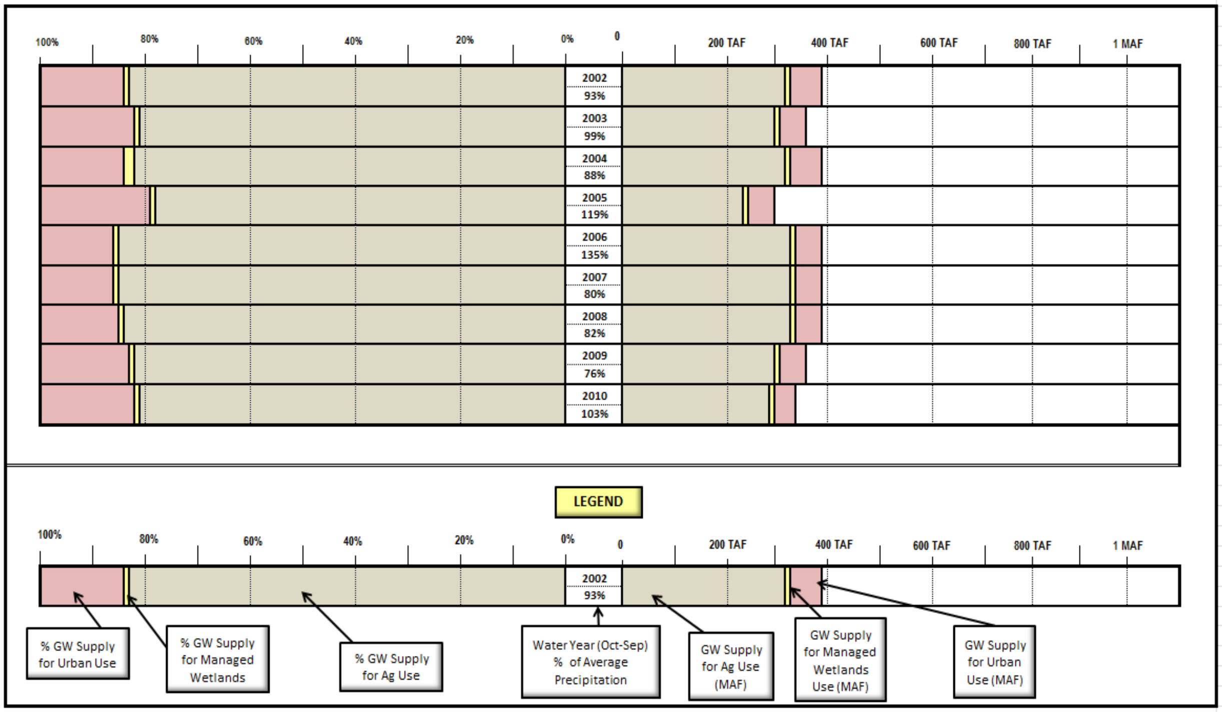
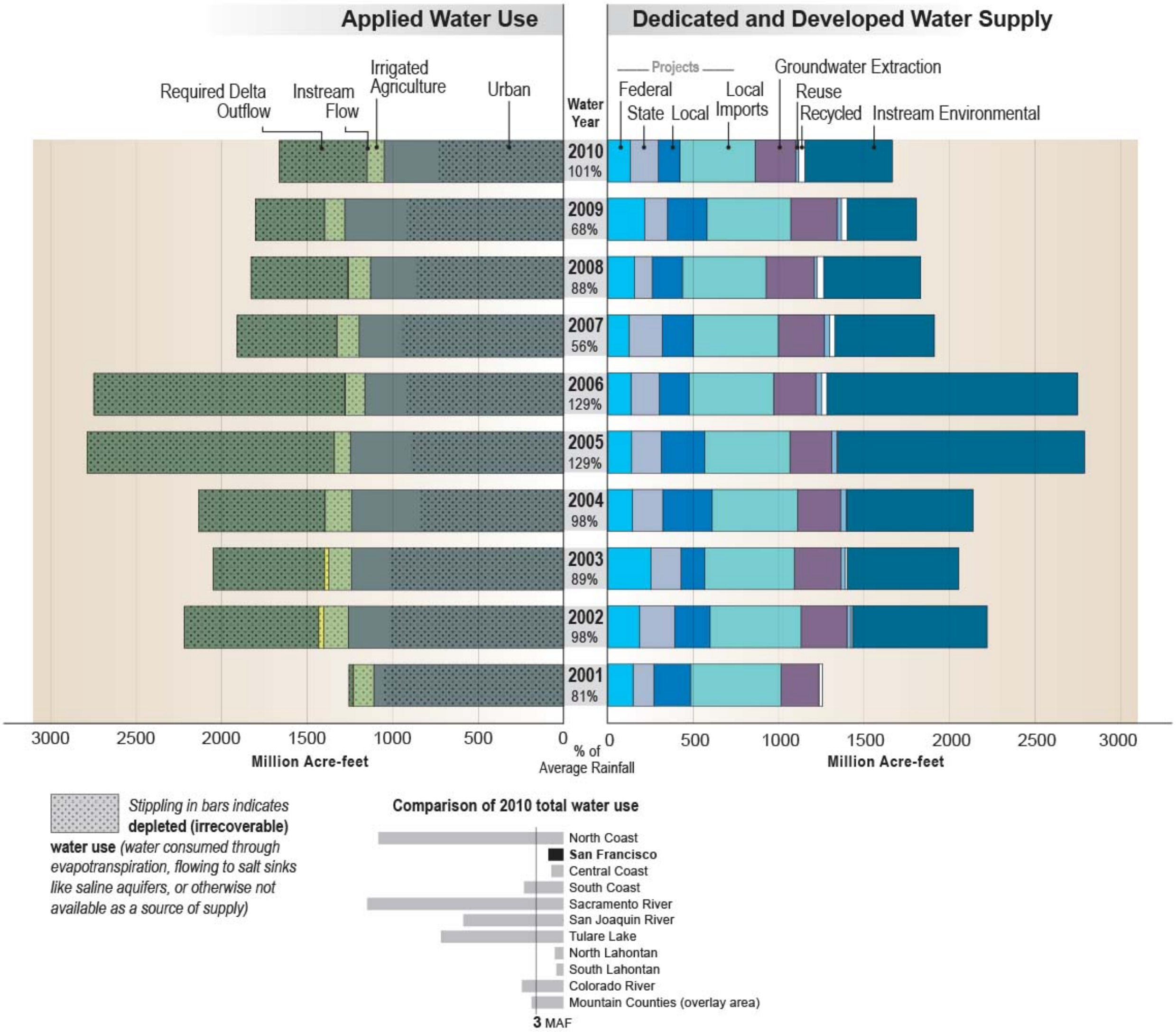


Figure SFB-14 San Francisco Bay Hydrologic Region Water Balance by Water Year, 2001-2010

California's water resources vary significantly from year to year. Ten recent years show this variability for water use and water supply. Applied Water Use shows how water is applied to urban and agricultural sectors and dedicated to the environment and the Dedicated and Developed Water Supply shows where the water came from each year to meet those uses. Dedicated and Developed Water Supply does not include the approximately 125 million acre-feet (MAF) of statewide precipitation and inflow in an average year that either evaporates, are used by native vegetation, provides rainfall for agriculture and managed wetlands, or flow out of the state or to salt sinks like saline aquifers. Groundwater extraction includes annually about 2 MAF more groundwater used statewide than what naturally recharges – called groundwater overdraft. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years.



Key Water Supply and Water Use Definitions

Applied water. The total amount of water that is diverted from any source to meet the demands of water users without adjusting for water that is depleted, returned to the developed supply or considered irrecoverable (see water balance figure).

Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

Instream environmental. Instream flows used only for environmental purposes.

Instream flow. The use of water within its natural watercourse as specified in an agreement, water rights permit, court order, FERC license, etc.

Groundwater Extraction. An annual estimate of water withdrawn from banked, adjudicated, and unadjudicated groundwater basins.

Recycled water. Municipal water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource.

Reused water. The application of previously used water to meet a beneficial use, whether treated or not prior to the subsequent use.

Urban water use. The use of water for urban purposes, including residential, commercial, industrial, recreation, energy production, military, and institutional classes. The term is applied in the sense that it is a kind of use rather than a place of use.

Water balance. An analysis of the total developed/dedicated supplies, uses, and operational characteristics for a region. It shows what water was applied to actual uses so that use equals supply.

San Francisco Water Balance by Water Year Data Table (MAF)

	2001 (81%)	2002 (98%)	2003 (89%)	2004 (98%)	2005 (129%)	2006 (129%)	2007 (56%)	2008 (72%)	2009 (72%)	2010 (101%)
Applied Water Use										
Urban	1110	1258	1242	1239	1248	1161	1196	1129	1280	1050
Irrigated Agriculture	120	144	131	156	93	115	128	129	116	98
Managed Wetlands	6	30	26	2	2	4	4	4	4	4
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	20	787	652	739	1444	1468	582	567	404	512
Wild & Scenic R.	0	0	0	0	0	0	0	0	0	0
Total Uses	**1257**	**2219**	**2051**	**2136**	**2788**	**2748**	**1910**	**1829**	**1804**	**1664**
Depleted Water Use (stippling)										
Urban	1054	1017	1018	837	894	917	955	863	916	733
Irrigated Agriculture	120	132	121	147	85	106	117	118	106	90
Managed Wetlands	6	28	25	2	2	4	4	4	4	4
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	20	787	651	739	1444	1468	582	567	404	512
Wild & Scenic R.	0	0	0	0	0	0	0	0	0	0
Total Uses	**1200**	**1965**	**1815**	**1725**	**2426**	**2495**	**1658**	**1552**	**1429**	**1339**
Dedicated and Developed Water Supply										
Instream	0	787	651	739	1,444	1,468	582	567	404	512
Local Projects	216	207	139	289	255	176	182	176	233	126
Local Imported Deliveries	530	532	523	499	499	493	497	489	490	440
Colorado Project	0	0	0	0	0	0	0	0	0	0
Federal Projects	147	184	253	144	139	135	123	156	214	131
State Project	121	207	175	177	172	165	195	104	133	164
Groundwater Extraction	220	268	275	252	245	247	268	281	272	239
Inflow & Storage	0	0	0	0	0	0	0	0	0	0
Reuse & Seepage	0	23	24	33	30	35	32	16	24	16
Recycled Water	22	11	12	4	5	30	31	41	35	36
Total Supplies	**1,257**	**2,219**	**2,051**	**2,136**	**2,788**	**2,748**	**1,910**	**1,829**	**1,804**	**1,664**

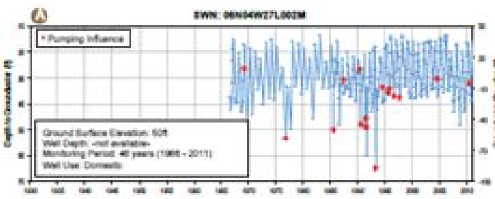
Figure SFB-15 Groundwater Level Trends in Selected Wells in the San Francisco Bay Hydrologic Region

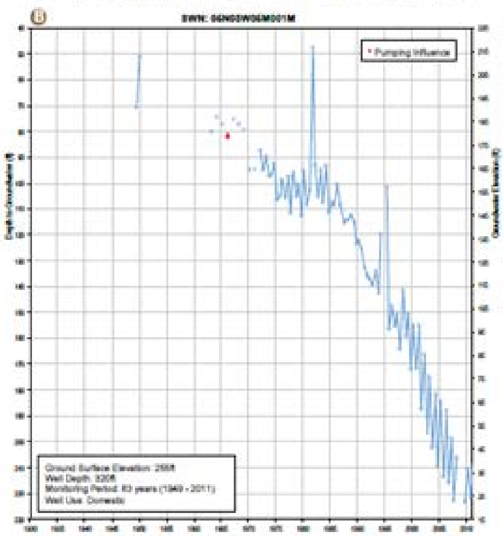
Figure X-x San Francisco hydrographs

Aquifer response to changing demand and management practices

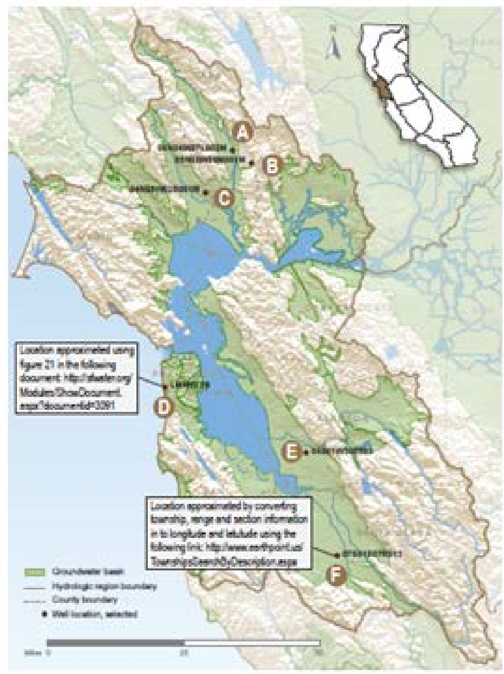
Hydrographs were selected to help tell a story of how local aquifer systems respond to changing groundwater demand and resource management practices. Additional detail is provided within the main text of the report.

A, B Hydrograph 06N04W27L002M and 05N03W05M001M: illustrate the dramatically different aquifer conditions underlying the Napa Valley Subbasin. SWN 06N04W27L002M is completed in the upper Sonoma Volcanics where the alluvial deposits are young and unconsolidated, thus, more permeable and better connected to the surface water sources as compared to SWN 05N03W05M001M which is completed in deeper alluvial deposits which are less permeable and not as well connected to the surface water source.





Regional locator map



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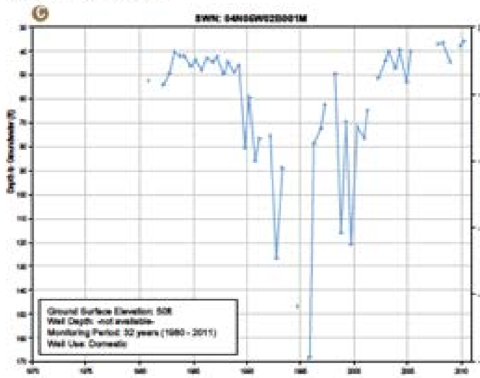
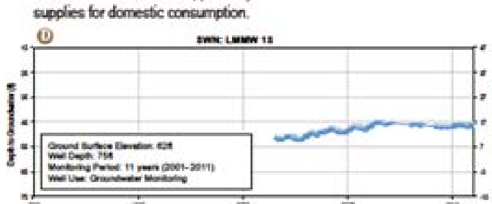
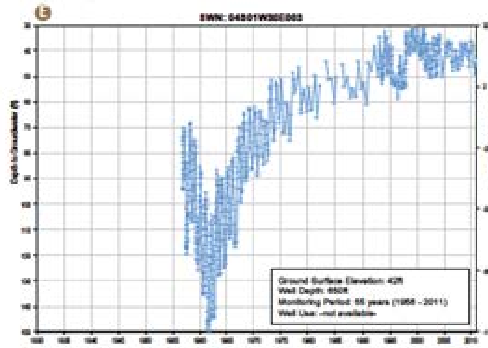
C **Hydrograph 04N05W02B001M**: highlights recovering groundwater levels associated with the implementation of in-lieu groundwater recharge project by substituting recycled water for groundwater to meet the agricultural water demand.



D **Hydrograph LMMW-1S**: shows groundwater elevations in an urban environment where groundwater elevations have generally remained stable over time, primarily due to use of surface water supplies for domestic consumption.



E, **F** **Hydrograph 04S01W30E003M and 07S01E07R013M**: illustrate the successful stabilization of sharply declining groundwater levels through introduction of imported water deliveries which resulted in decreasing groundwater demand, and facilitating in-lieu and active groundwater recharge programs.



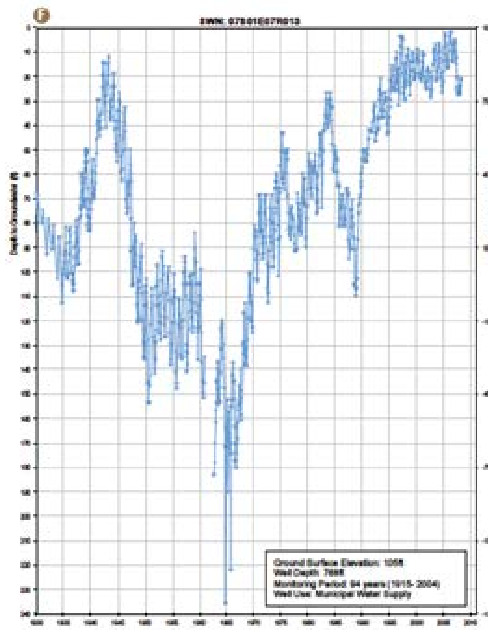
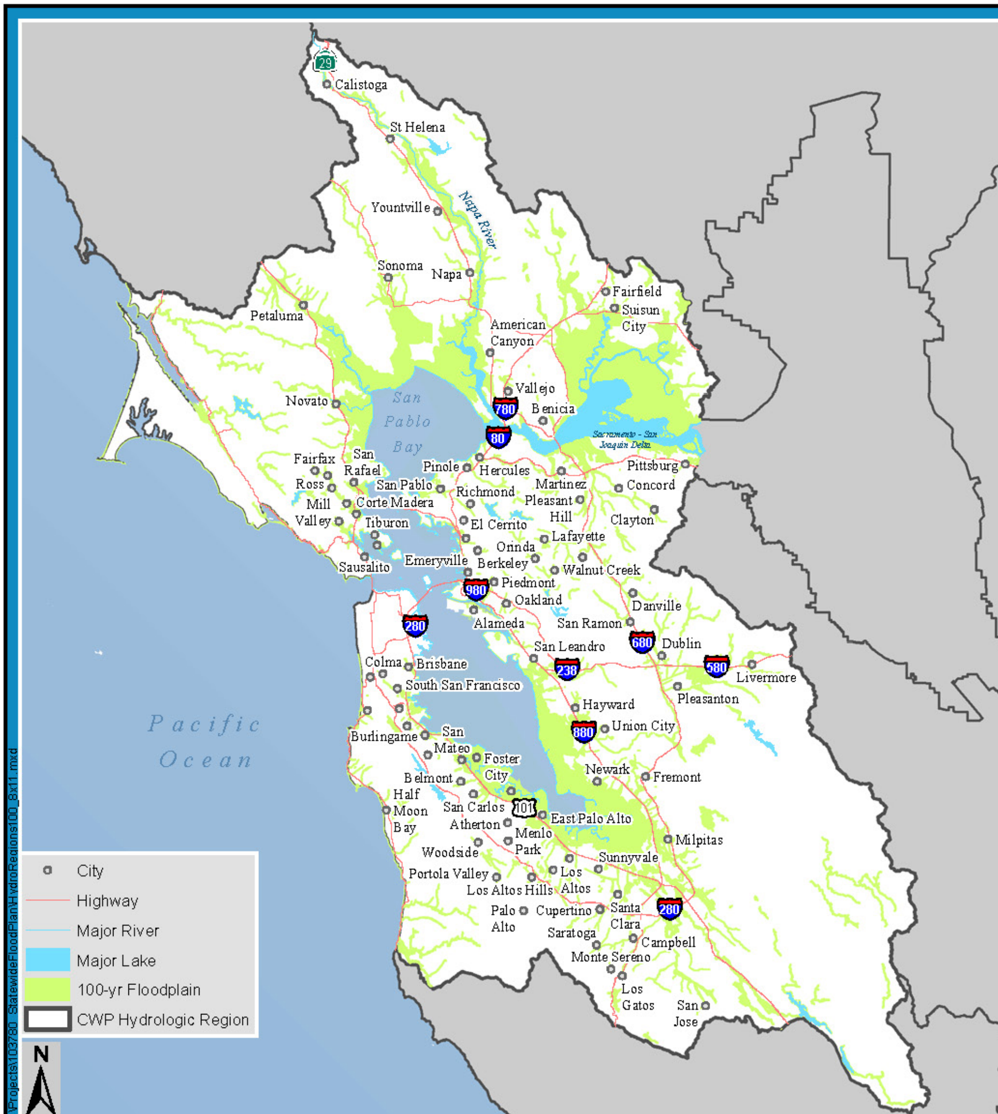


Figure SFB-16 San Francisco Bay — Statewide Flood Hazard Exposure to the 100-Year Floodplain



San Francisco Bay Key Results

Total Population:	6,066,100	Transportation Facilities:	560
Population Exposed:	355,000	Transportation Segments (miles):	361
Percent of Population Exposed:	6	Essential Facilities:	140
Exposed Structures:	109,800	Lifeline Utilities:	47
Value of Exposed Structure and Contents:	$46.2 Billion	Dept. of Defense Facilities:	8
Total Area (acres)	2.9 Million	Dept. of Defense Facilities (acres):	2,813
Exposed Area (acres)	446,000	High Potential Loss Facilities:	168
Percent of Area Exposed:	15	Native American Tribes:	-
Exposed Ag.Crops (acres):	33,300	Native American Tribal Lands (acres):	-
Percent of Ag. Crops Exposed:	23	Sensitive Animal Species Exposed:	106
Value of Exposed Ag. Crops:	$17.3 Million	Sensitive Plant Species Exposed:	167

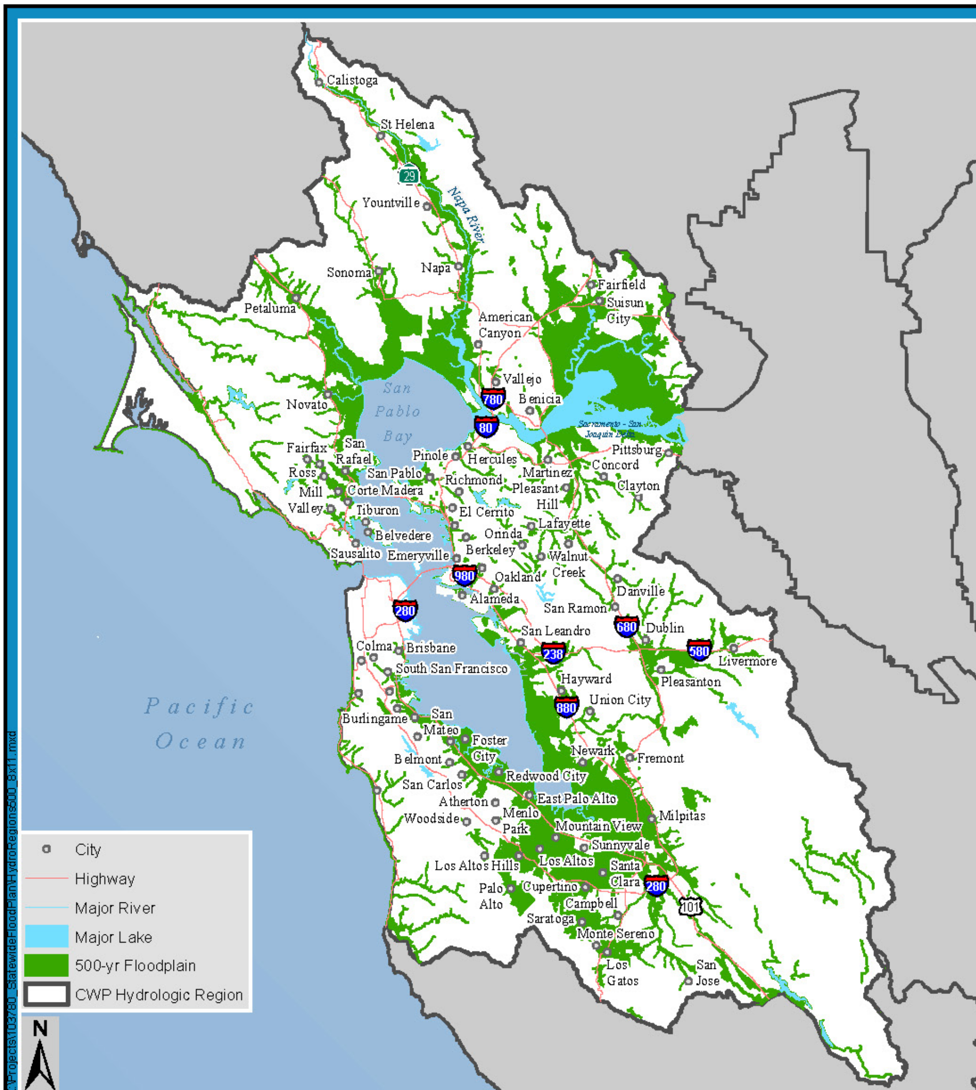
Statewide Flood Hazard Exposure Summary for the San Francisco Bay Hydrologic Region 100-year Floodplain

STATEWIDE FLOOD MANAGEMENT PLANNING PROGRAM

FloodSAFE CALIFORNIA

Jan 28, 2013

Figure SFB-17 San Francisco Bay — Statewide Flood Hazard Exposure to the 500-Year Floodplain



San Francisco Bay Key Results			
Total Population:	6,066,100	Transportation Facilities:	1,022
Population Exposed:	1,041,400	Transportation Segments (miles):	709
Percent of Population Exposed:	17	Essential Facilities:	466
Exposed Structures:	322,700	Lifeline Utilities:	58
Value of Exposed Structure and Contents:	$133.8 Billion	Dept. of Defense Facilities:	8
Total Area (acres)	2.9 Million	Dept. of Defense Facilities (acres):	2,914
Exposed Area (acres)	553,600	High Potential Loss Facilities:	303
Percent of Area Exposed:	19	Native American Tribes:	-
Exposed Ag.Crops (acres):	44,000	Native American Tribal Lands (acres):	-
Percent of Ag. Crops Exposed:	31	Sensitive Animal Species Exposed:	110
Value of Exposed Ag. Crops:	$23.9 Million	Sensitive Plant Species Exposed:	169

Statewide Flood Hazard Exposure Summary for the San Francisco Bay Hydrologic Region 500-year Floodplain

STATEWIDE FLOOD MANAGEMENT PLANNING PROGRAM

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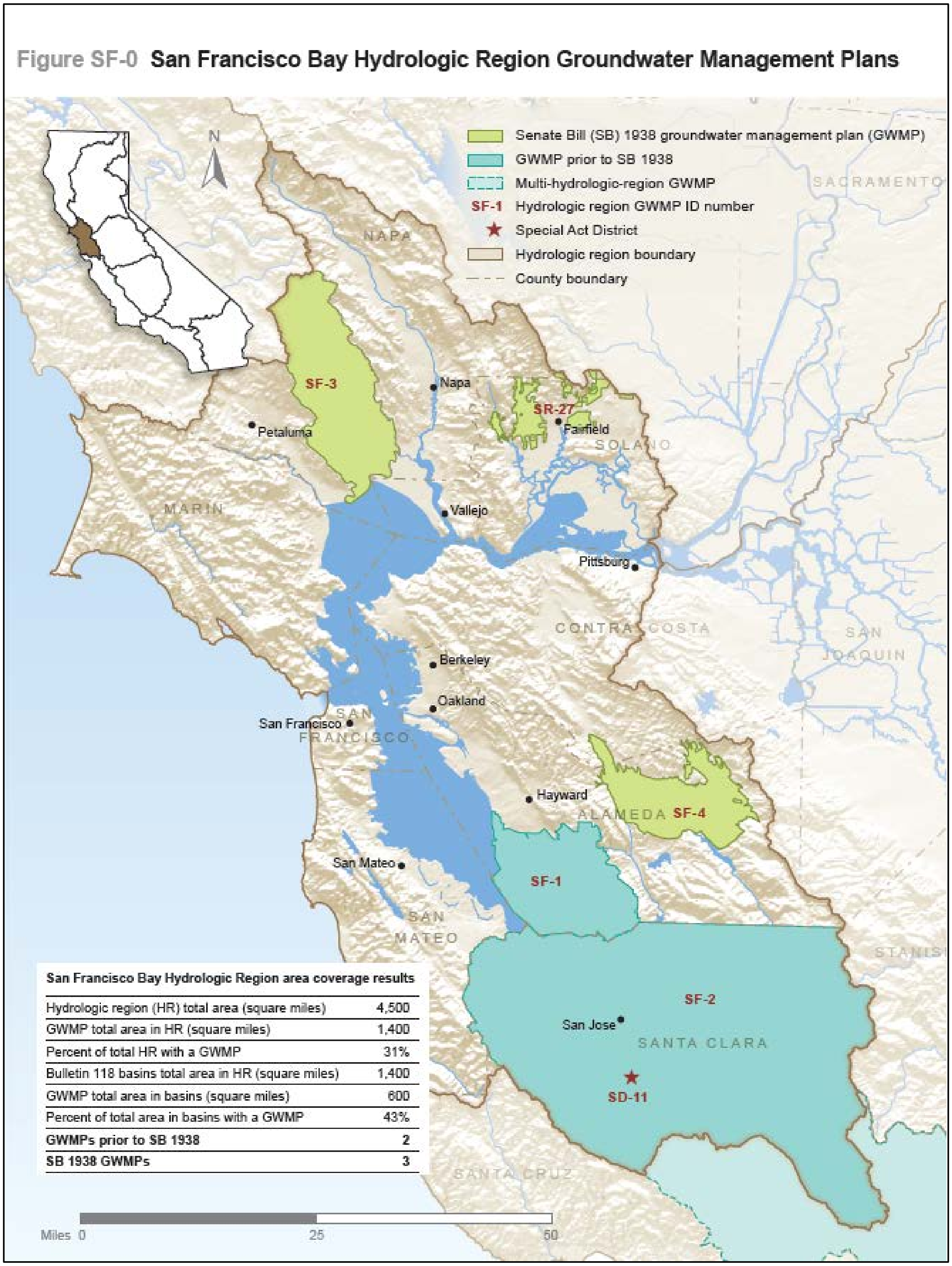
Figure SFB-18 Integrated Regional Water Management Groups in the San Francisco Bay Hydrologic Region

[figure to come]

Figure SFB-19 Location of Groundwater Management Plans in the San Francisco Bay Hydrologic Region



San Francisco Bay Hydrologic Region area coverage results	
Hydrologic region (HR) total area (square miles)	4,500
GWMP total area in HR (square miles)	1,400
Percent of total HR with a GWMP	31%
Bulletin 118 basins total area in HR (square miles)	1,400
GWMP total area in basins (square miles)	600
Percent of total area in basins with a GWMP	43%
GWMPs prior to SB 1938	**2**
SB 1938 GWMPs	**3**

Figure SFB-20 Water Imports to the San Francisco Bay Hydrologic Region

[figure to come]

Figure SFB-21 Change in San Francisco Bay Agricultural and Urban Water Demands for 117 Scenarios from 2006-2050 (thousand acre-feet per year)

Figure SFB-22 Integrated Water Management Planning in the San Francisco Bay Region

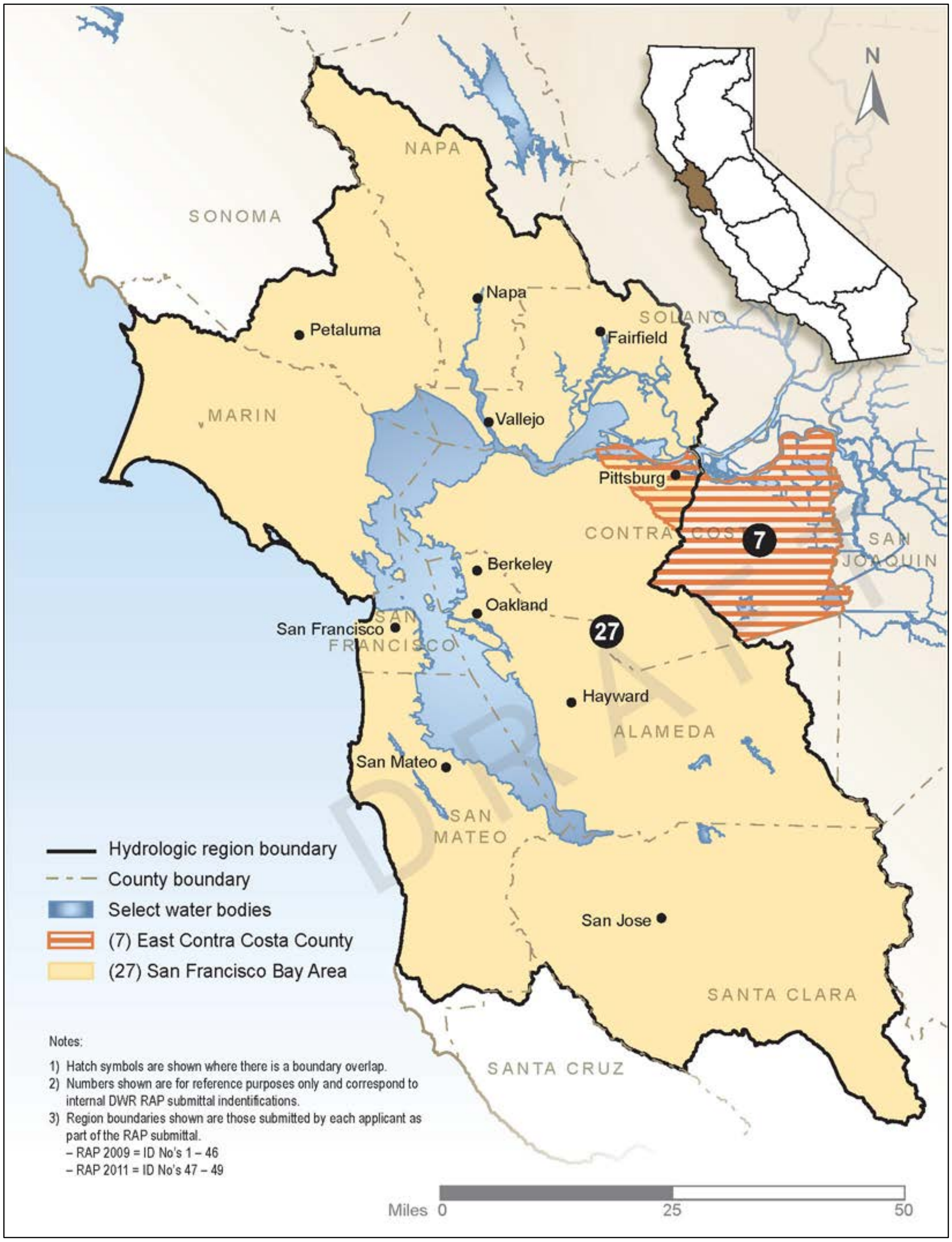


Figure SFB-23 Energy Intensity of Raw Water Extraction and Conveyance in the San Francisco Bay Hydrologic Region

Type of Water	Energy Intensity (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)		12%
State (Project)		12%
Local (Project)	 <250 kWh/AF	15%
Local Imports	 *<250 kWh/AF	38%
Groundwater		19%

* Hetch Hetchy is a net energy provider

Energy Intensity per Acre-Foot of Water

Energy intensity (EI) in this figure is the total amount of energy required for the extraction and conveyance of one acre-foot of water and does not include treatment, distribution to point of use, or end use energy (e.g., water heating). These figures should be seen as ranges within which the EI of different sources of each water type would likely fall i.e., a water type with four bulbs should be interpreted to mean that most sources of that water type in the region would have an EI of between 1,501-2,000 kWh/acre-ft of water. Smaller light bulbs represent an EI of greater than zero, and less than250 kWh/acre-ft. EI of desalinated and recycled water is not shown, but is covered in Resource Management Strategies #XX and #YY respectively, Volume 3. (For detailed description of the methodology used to calculate EI in this figure, see Volume 5, *Technical Guide*, or Volume 4, *Reference Guide*).

Box SFB-1 California Statewide Groundwater Elevation Monitoring (CASGEM) Basin Prioritization Data Considerations

Senate Bill 7x 6 (SBx7 6; Part 2.11 to Division 6 of the California Water Code § 10920 et seq.) requires, as part of the CASGEM program, DWR to prioritize groundwater basins to help identify, evaluate, and determine the need for additional groundwater level monitoring by considering available data listed below:.

1. The population overlying the basin,
2. The rate of current and projected growth of the population overlying the basin,
3. The number of public supply wells that draw from the basin,
4. The total number of wells that draw from the basin,
5. The irrigated acreage overlying the basin,
6. The degree to which persons overlying the basin rely on groundwater as their primary source of water,
7. Any documented impacts on the groundwater within the basin, including overdraft, subsidence, saline intrusion, and other water quality degradation, and
8. Any other information determined to be relevant by the DWR.

Using groundwater reliance as the leading indicator of basin priority, DWR evaluated California's 515 alluvial groundwater basins and categorized them into five groups:

- Very High
- High
- Medium
- Low
- Very Low

Box SFB-2 New Feature — Near-Coastal

Coastal regions in California share common concerns and issues. The update of the California Water Plan 2013 is introducing a focus on near-coastal issues. The issues common to all coastal areas include increased coastal flooding especially as it relates to climate change, sea level rise, and the potential degradation of aquifer water quality. Desalination may be a future water supply source for drinking water, and impacts on adjacent water conditions and ecosystems are of concern. Stormwater and wastewater management are significant near-coastal issues, including the impacts of runoff and discharge on coastal water quality. Near coastal planners and resource managers have increased attention to ecological linkages between freshwater flows, wetlands, and anadromous fish species. Conjunctive water management strategies as applied in near coastal areas consider groundwater management for recharge and water supply for multiple land uses and objectives.

Climate change is anticipated to have profound effects on the North Coast regions, as the effects of climate change will alter rain patterns and intensity and well as temperatures. Because of the interrelationship of water supply, quality, floods and flooding, land use and fisheries, coastal managers are relying on current science and recommended strategies for adaptation and resource management. These shared concerns, issues, approaches and strategies are discussed relevant to the San Francisco Bay region.

Find information on near-coastal issues in the San Francisco Bay region under the “Flood Management” and “Climate Change” sections, as well as “Recent Initiatives” and “Ecosystem Restoration.” In Volume 4, Near-Coastal Issues are discussed in the article, “XXXXXXX.”

Box SFB-3 Planning Organizations, San Francisco Bay Hydrologic Region

Bay Area/North Coast/Central Coast Water Quality and Sustainability Work Group. This workgroup was formed to identify and describe the connections between water quality and climate change on the coast from central California to the Oregon border, as well as recommend actions in the water quality arena that can help reduce greenhouse gases or help solve climate change problems.

Bay Area Water Supply and Conservation Agency (BAWSCA). BAWSCA represents the interests of 26 cities and water districts, and two private utilities that purchase wholesale water from the San Francisco Public Utilities Commission (SFPUC) regional water system. BAWSCA's goals are to ensure high quality, reliable water supply for the 1.7 million people residing in Alameda, Santa Clara, and San Mateo Counties who depend on the SFPUC regional water system. (Website: www.bawsca.org)

Association of Bay Area Governments (ABAG). Formed in 1961, ABAG is the official comprehensive planning agency for the Bay Region. ABAG's mission is to strengthen cooperation and coordination among local governments to address social, environmental, and economic issues that transcend local borders. (Website: www.ABAG.ca.gov)

Bay Area Water Agencies Coalition (BAWAC). The coalition was established in 2002 to provide a forum and a framework for water agency general managers to discuss water management planning issues and coordinate projects and programs to improve water supply reliability and water quality.

Northern California Salinity Coalition. This coalition of eight water agencies was created in 2003 to advance local and regional efforts to use desalination or salinity management technologies that reduce salinity problems and improve water supply reliability for member agencies.

Bay Area Clean Water Agencies (BACWA). Founded in 1984, BACWA is an association comprised of local governmental agencies that own and operate treatment works that discharge into the San Francisco Bay Estuary. BACWA's members serve more than 6 million people in the Bay Area, treating all domestic and commercial wastewater and a significant volume of industrial wastewater. (Website: www.bacwa.org)

Bay Planning Coalition (BPC). Established in 1983, the BPC is a nonprofit, membership-based organization representing the maritime industry and related shoreline business, ports and local governments, landowners, recreational users, environmental and business organizations, and professional service firms in engineering, construction, law, planning, and environmental sciences. (Website: www.bayplanningcoalition.org)

Bay Area Flood Protection Agencies Association (BAFPAA). Established in 2006 as an outgrowth of the Bay Area IRWM process, membership in BAFPAA includes Bay Area counties and special districts with responsibility for flood protection and storm water management.

San Francisco Bay Area Integrated Regional Water Management Group. The Bay Area IRWM Group is an important regional water resources planning organization. It outlines the region's water resources management needs and objectives, and presents innovative strategies and a detailed implementation plan to achieve the objectives. (Website: www.bairwmp.org)

Bay Area Watershed Network (BAWN). The network was organized in 2006 to bring together a wide variety of agencies, technical experts, and nongovernmental organizations (NGOs) with diverse expertise to work on proposals and activities involving watershed management, planning, and restoration. Smaller teams work on policy, coordination with the IRWM process, assessment and monitoring tools, and education and outreach activities. (Meeting information at www.sfbayjv.org)

Metropolitan Transportation Commission (MTC). MTC is the transportation planning, coordinating, and financing agency for Bay Area Rapid Transit (BART) and other major regional transit systems.

Joint Policy Committee (JPC). JPC coordinates the regional planning efforts of ABAG, the Bay Area Air Quality Management District (BAAQMD), BCDC, and MTC; and pursues implementation of the Bay Region's Smart Growth Vision.

Bay Area Stormwater Management Agencies Association (BASMAA). BASMAA was started by local governments in response to the National Pollutant Discharge Elimination System (NPDES) permitting program. It promotes a regional consistency to improving the quality of stormwater runoff into the San Francisco Bay and Delta. BASMAA encourages cooperation and information-sharing to develop cost-effective regional products and programs.

San Francisco Estuary Partnership (SFEP). SFEB is a coalition of resource agencies, non-profits, citizens, and scientists working to protect, restore, and enhance water quality and fish and wildlife habitat in and around the San Francisco Bay Delta Estuary.

Box SFB-4 Other Groundwater Management Planning Efforts in the San Francisco Bay Hydrologic Region

The Integrated Regional Water Management plans, Urban Water Management plans, and Agriculture Water Management plans in the San Francisco Bay Hydrologic Region that also include components related to groundwater management are briefly discussed below.

Integrated Regional Water Management Plans

There is one IRWM region that covers the entire San Francisco Bay Hydrologic Region. The Bay Area IRWM Region was approved in 2009 through DWR's Region Acceptance Process to maximize opportunities to integrate local water management activities and promote partnerships and multi-objective projects that benefit local communities and the natural environment (http://bairwmp.org/). The five overarching goals of the Bay Area IRWMP are to promote environmental, economic and social sustainability; improve water supply reliability and quality; protect and improve watershed health and function and Bay water quality; improve regional flood management; and create, protect, enhance, and maintain environmental resources and habitats (BAIRWMP, 2013). The 2006 Bay Area IRWMP is currently being updated using a Proposition 84 IRWM Planning Grant.

Urban Water Management Plans

Urban Water Management plans are prepared by California's urban water suppliers to support their long-term resource planning and to ensure adequate water supplies are available to meet existing and future water uses. Urban use of groundwater is one of the few uses that meter and report annual groundwater extraction volumes. The groundwater extraction data is currently submitted with the Urban Water Management plan and then manually translated by DWR staff into a database. Online methods for urban water managers to directly enter their water use along with their plan updates is currently under evaluation and review by DWR. Because of the time-line, the plans could not be reviewed for assessment for Water Plan Update 2013.

Agricultural Water Management Plans

Agricultural Water Management plans are developed by water and irrigation districts to advance the efficiency of farm water management while benefitting the environment. New and updated Agricultural Water Management plans addressing several new requirements were submitted to DWR by December 31, 2012 for review and approval. These new or updated plans provide another avenue for local groundwater management, but because of the time-line, the plans could not be reviewed for assessment for Water Plan Update 2013.

Box SFB-5 Statewide Conjunctive Management Inventory Effort in California

The effort to inventory and assess conjunctive management projects in California was conducted through literature research, personal communication, and documented summary of the conjunctive management projects. The information obtained was validated through a joint DWR-ACWA survey. The survey requested the following conjunctive use program information:

1. Location of conjunctive use project;

2. Year project was developed;

3. Capital cost to develop the project;

4. Annual operating cost of the project;

5. Administrator/operator of the project; and

6. Capacity of the project in units of acre-feet.

To build on the DWR/ACWA survey, DWR staff contacted by telephone and email the entities identified to gather the following additional information:

7. Source of water received;
8. Put and take capacity of the groundwater bank or conjunctive use project;
9. Type of groundwater bank or conjunctive use project;
10. Program goals and objectives; and
11. Constraints on development of conjunctive management or groundwater banking (recharge) program.

Statewide, a total of 89 conjunctive management and groundwater recharge programs were identified. Conjunctive management and groundwater recharge programs that are in the planning and feasibility stage are not included in the inventory.

SFPUC
WATER
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EBMUD

Via Electronic & U.S. Mail

July 24, 2008

Mr. Mark Baldassare, President and CEO
Public Policy Institute of California
500 Washington Street, Suite 600
San Francisco, CA 94111

Dear Mr. Baldassare:

The recently released report from the Public Policy Institute of California (Institute), entitled "Comparing Futures for the Sacramento San Joaquin Delta" will generate much discussion and analysis in the coming weeks and months. To help foster objectivity in the coming discussions, we wish to comment about the repeated use of the term "upstream diversions," which bolsters oversimplified notions of how to address Delta challenges by cutting back on all diversions.

In multiple locations "Comparing Futures" refers to upstream diverters being responsible for diversion and consumptive use of over 25% of the Delta's average natural inflows, and identifies "such major diversions as" the Tehama-Colusa Canal, the Friant Kern Canal, San Francisco's Hetch Hetchy Aqueduct and EBMUD's Mokelumne Aqueduct. This inappropriately implies that EBMUD and the San Francisco Public Utility Commission (SFPUC) are withdrawing a huge amount of water from the Delta watershed, even exceeding the exporters' diversions. This is a serious distortion. The Delta Vision report issued by the Governor's Blue Ribbon Task made a similar characterization that EBMUD and San Francisco corrected in June 2008.

Attachment 1 shows the true proportion of EBMUD's and SFPUC's diversions in relation to the total Delta outflow and to project exports, using the same data the Delta Vision report utilized. In this bar chart, the portion taken by our two agencies is barely visible, at less than 1.5% of the total diversions. We suggest that it would be far more constructive to use this chart, or a similarly accurate one, in describing the relative diversions of the various water users.

Both EBMUD and SFPUC have gone to great lengths to properly manage the tributary rivers from which they divert to ensure that the ecosystems on those rivers are healthy. Both agencies have invested millions of dollars in water conservation to ensure that no more water is diverted than is absolutely necessary.

Naming our two agencies out of context in “Comparing Futures” creates the erroneous impression that we are the major diverters. The facts are entirely in opposition to this inference. PPIC researchers failed to make important distinctions in making this statement. We find this mischaracterization to be highly distressing and counterproductive.

We believe that durable solutions for the Delta are within reach, and that all parties will have to contribute to a sustainable Delta in a fair and reasonable manner. We appreciate and support all efforts to move beyond entrenched positions, and pledge our continued participation to that end.

Sincerely,

Edward Harrington General Manager San Francisco Public Utilities Commission	Dennis M. Diemer General Manager East Bay Municipal Utility District

DMD:RK:BC

Attachment

cc: Mike Chrisman, Secretary, California Resources Agency

Historic Diversion from the Delta and Watershed Consumptive Uses